APEX

*Feasibility Study*
*Willamette Cove Upland Facility*
*Portland, Oregon*

Prepared for:
Port of Portland

October 3, 2014
1056-04

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*Michael Pickering, R.G.*
*Senior Associate Hydrogeologist*

REGISTERED PROFESSIONAL ENGINEER
15,147 PE
OREGON
OCT. 2, 1990
HERBERT F. CLOUGH
EXPIRES: DEC. 31, 2015

*Herb Clough, P.E.*
*Principal Engineer*

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# Abbreviations/Acronyms

| | |
|---|---|
| BaP | Benzo(a)pyrene |
| bgs | Below the Ground Surface |
| BNSF | Burlington Northern Santa Fe |
| cfs | Cubic Feet Per Second |
| COCs | Chemicals of Concern |
| COPCs | Chemicals of Potential Concern |
| cy | Cubic Yards |
| DEQ | Oregon Department of Environmental Quality |
| ECSI | Environmental Cleanup Site Information |
| ELCR | Excess Lifetime Cancer Risk |
| EPA | U.S. Environmental Protection Agency |
| Facility | Willamette Cove Upland Facility |
| FS | Feasibility Study |
| HPAHs | High Molecular Weight Polycyclic Aromatic Hydrocarbons |
| LOAEL | Lowest Observed Adverse Effects Level |
| Mg/kg | Milligrams per Kilogram |
| NAPL | Non-Aqueous Phase Liquid |
| NPV | Net Present Value |
| OS | Open Space |
| PAHs | Polycyclic Aromatic Hydrocarbons |
| PCBs | Polychlorinated Biphenyls |
| PDC | Portland Development Commission |
| Port | Port of Portland |
| PRGs | Preliminary Remediation Goals |
| RAOs | Remedial Action Objectives |
| RERA | Residual Ecological Risk Assessment |
| RHHRA | Residual Human Health Risk Assessment |
| RI | Remedial Investigation |
| TQ | Toxicity Quotients |
| sf | Square Feet |
| SMP | Soil Management Plan |
| SVOCs | Semi-Volatile Organic Compounds |
| UPRR | Union Pacific Railroad |
| VCP Agreement | Voluntary Cleanup Program Agreement |

# 1.0 Introduction

This report presents the feasibility study (FS) for the Willamette Cove Upland Facility (the Facility). The FS is being performed as part of Voluntary Cleanup Agreement EC-NWR-00-26 (VCP Agreement) between the Port of Portland (Port), Metro, and the Oregon Department of Environmental Quality (DEQ). The Facility is defined in the DEQ Environmental Cleanup Site Information (ECSI) database as ECSI No. 2066.

## 1.1 Purpose

The purpose of the FS is to evaluate remedial options and recommend a remedial alternative in accordance with the requirements of DEQ rules and guidance that addresses the unacceptable baseline risk identified in the Residual Ecological Risk Assessment (RERA; Formation, 2014a), the Residual Human Health Risk Assessment (RHHRA; Formation, 2013), and the evaluation of 2014 soil samples (Formation, 2014b).

## 1.2 Report Organization

The following is a brief overview of the organization of the report.

Site Background. Section 2 describes the Facility; site history; current conditions and proposed uses; soil, groundwater, and surface water; and previous environmental investigations and actions.

Risk Assessment Summary. Section 3 summarizes the results of the ecological and human health residual risk assessments and updated risk screening of data collected in 2014. The summary identifies areas that are above acceptable risk levels and high concentration hot spot levels.

Site Model. The information from Sections 2 and 3 is synthesized in Section 4 to identify the key information needed to complete the FS. This summary includes the nature and extent of contaminants, existing conditions, presumed future site use, and coordination requirements for other Portland Harbor cleanup activities.

Remedial Action Objectives and Remedial Action Area. Section 5 defines and discusses the appropriate remedial action objectives (RAOs) for Willamette Cove and the criteria by which potential remedial action alternatives will be evaluated. The extent of the areas that exceed acceptable baseline risk levels, hot spot levels, or remediation levels are described in Section 6.

Technology Evaluation and Remedial Action Alternatives. A list of general response actions are developed and presented in Section 7 to address the conditions encountered in the remedial action areas described in Section 6. These general response actions form the basis for generating and screening technologies. Potential remedial technologies were developed for each general response action identified.

Technologies were then evaluated with respect to specific site conditions, waste characteristics, and the ability to achieve the RAOs. The technologies remaining after the screening process were then combined to create potential alternatives for further detailed analysis.

Detailed Analysis of Remedial Alternatives. The potentially feasible remedial action alternatives are more fully developed in Section 8. The protective alternatives are evaluated on the basis of the balancing factors (effectiveness; long-term reliability; implementability; implementation risk; and reasonableness of cost) and the degree to which the alternative addresses removal or treatment of hot spots. The evaluation includes sufficient detail to identify comparative or relative differences among alternatives.

Comparative Evaluation of Remedial Action Alternatives and Recommendation. After completion of the detailed screening, the feasible remedial alternatives are ranked in Section 9 on the basis of a comparative analysis within the balancing factors. Based on the results of the comparison rankings, a remedial action alternative is recommended. The recommended remedial action alternative is discussed in Section 10.

# *2.0 Background*

## 2.1 Site Description

The Facility is located along the northeast bank of the Willamette River in the St. Johns area of Portland, Oregon. Figure 1 shows the location of the Facility. The Facility is situated between River Miles 6 and 7 on the Willamette River and is mostly in Section 12 of Township 1 North, Range 1 West, Willamette Meridian. The Facility has been owned by Metro since 1996. Figure 2 provides a current plan of the Facility as well as the surrounding area. For purposes of describing the Facility, it has been divided into West, Central, and East Parcels as shown on Figure 2.

Extent of the Upland Facility. The Facility as defined in the VCP Agreement covers approximately 24 acres of upland area that is inland from the mean high water line (defined as 13.3 feet, NAVD88 datum) to the Union Pacific Railroad (UPRR). The upland portion is approximately 3,000 feet long and varies from 110 to 700 feet in width. The cove is set in up to 800 feet from the main river channel; it was created primarily as a result of the placement of the embankment leading up to the railroad bridge.

Access. The Facility is accessible by vehicle from North Edgewater Street. A locked gate is present at the north end of North Edgewater Street one block south of its intersection with North Willamette Boulevard. Unimproved roadways are present on the Central and East Parcels but vehicle access is limited by concrete blocks/rubble at multiple locations. Access to the area by foot or from the river is possible.

**Structures and Improvements.** There are no structures on the Facility. Indications of previous structures include a large concrete foundation and a paved roadway in the eastern portion of the Facility, several smaller concrete structures or foundations, and structural piling within the cove and along the riverbank. Riprap is present along much of the riverbank.

**Topography.** The Facility is situated on a terrace created by historical filling. Overall, the topography of this terrace is flat, with an elevation ranging between 30 and 45 feet (all elevations NAVD88). The southern portion of the West Parcel is slightly higher, at elevation 50 to 55 feet. Berms and hummocks are occasionally present. The riverbank is generally a steep 20- to 30-foot slope down to the river. The river water elevation is typically less than 10 feet and is subject to a mean tidal range of about 2 feet.

The Burlington Northern Santa Fe (BNSF) railroad embankment along the southeast perimeter of Willamette Cove rises steeply about 50 feet above the cove. North of the property, across the UPRR tracks, is a naturally formed 120- to 150-foot-high bluff. By the Central and East Parcels, this bluff rises at approximately 5H:4V. Near the West Parcel, the slope is approximately 10H:3V.

**Vegetation.** A future development planning document (Alta Planning and Design, 2010) summarizes results from a natural resource assessment of the Facility completed in 1999. Appendix A includes a figure excerpted from the report showing the major vegetation communities on the Facility. The midstory trees include native species such as madrone and Oregon white oak.

**Surrounding Properties.** The Facility is bordered on the northeast by the UPRR tracks. Farther to the northeast is a vegetated bluff. A residential area is present on top of the bluff and farther inland. Bordering the northwest side of the Facility is a vacated portion of North Richmond Avenue with industrial property beyond. To the southeast is an embankment for a railroad bridge over the Willamette River for the BNSF railroad. On the opposite side of this embankment is the former McCormick & Baxter Creosoting Company, a federal Superfund Site. The southern portion of the East Parcel of the Facility has been impacted by a contaminant plume (including polycyclic aromatic hydrocarbons [PAHs], semi-volatile organic compounds [SVOCs], dioxins/furans, arsenic, chromium, copper, zinc, pentachlorophenol, and non-aqueous phase liquids [NAPL]) emanating from the McCormick & Baxter Creosoting Company Superfund Site. The McCormick & Baxter contaminant plume has migrated northwestward from McCormick & Baxter's former wood treatment operations, under the railroad embankment, and has emerged in the sediments of Willamette Cove. DEQ, acting on behalf of the U.S. Environmental Protection Agency (EPA), has implemented a remedial action consisting of a subsurface barrier wall and sediment cap to address the McCormick & Baxter contaminant plumes and NAPL seeps in Willamette Cove.

## 2.2 Historical Site Use

**West Parcel.** The West Parcel was originally developed in 1901 as a plywood mill, and operated as a wood products facility into the 1970s. The property was purchased by the Portland Development Commission

(PDC) in 1979. The property has remained vacant since. In 1996, the property was sold to Metro for the purpose of creating a green space area to be used as a public park.

**Central Parcel.** The Central Parcel was developed in 1903 in conjunction with the construction of the St. Johns Dry Docks in Willamette Cove. Between 1903 and 1924, shops and ancillary structures that provided support for dry dock activities were constructed. The dry docks were closed in 1953. The western portion of the Central Parcel was sold in 1950 and it was incorporated into the plywood and lumber mill operations on the adjacent West Parcel. The remainder of the Central Parcel was sold in 1953 and developed as a sawmill. By 1970, the sawmill was no longer in use. Up until 1981, portions of the property were used for a variety of purposes such as log rafting, a marine salvage company, a demolition contractor, woodworking facilities, and a boat builder. By 1981, the property was purchased by PDC, and PDC demolished the buildings by 1982. The property has remained vacant since. In 1996, the property was sold to Metro for the purpose of creating a green space area to be used as a public park.

**East Parcel.** The East Parcel was historically occupied by a cooperage plant (i.e., wood barrel manufacturer) from 1915 until the 1950s (when declining demand led to a focus on plywood production). Until 1980, a variety of wood-product-related businesses occupied the parcel. PDC purchased the property in 1980 and demolished the buildings by 1982. The property has remained vacant since. In 1996, the property was sold to Metro for the purpose of creating a green space area to be used as a public park.

## 2.3 Current Site Use

The Facility is currently vacant, covered with invasive and native vegetation, and it provides habitat for opportunistic use by wildlife. The site is not managed for any human use and is posted to prohibit trespassing. However, trespassers do come on the site (e.g., homeless persons and joggers).

The Facility is currently zoned as an Open Space (OS) zone with “g” (River General) and “q” (River Water Quality) greenway overlay zones (City of Portland, 2004). The Open Space zone is intended to preserve and enhance public and private open, natural, and improved park and recreational areas. Greenway regulations are also intended to protect, conserve, enhance, and maintain the natural, scenic, historical, economic, and recreational qualities of lands along Portland’s rivers. Specifically, the “g” overlay is intended to allow public use and enjoyment of the waterfront and for enhancement of the river’s scenic and natural qualities. The “q” overlay is designed to protect the functional values of water quality resources by limiting or mitigating the impact of development in the 50- to 200-foot setback from the top of bank. Other nearby zoning includes commercial (EG2), residential (R2 and R5), open space (OS), and industrial (IH and IG2; City of Portland, 2004).

The Facility is included in a citywide inventory that identified scenic resources (City of Portland, 2012). The Facility is identified as a scenic viewpoint. The zoning map shows a multi-use trail through the Facility (City of Portland, 2004). However, this trail is only proposed as part of the regional trail plan adopted by Metro (Alta Planning and Design, 2010) – see further discussion in Section 2.4.

## 2.4 Future Site Use

Portland Parks and Recreation prepared a draft management plan for the Facility (City of Portland, 1999). That report indicated that one potential plan for the Facility would be a park featuring urban natural areas with passive recreation opportunities. The plan includes a "Cottonwood Forest" zone in the East Parcel that would have clusters of large trees, a natural resources education area for children, a rustic picnic area (see further discussion below), bird watching opportunities, and a parking lot for up to 40 vehicles. The Portland Bureau of Parks and Recreation has also identified the need for a park in this area, listing both Willamette Cove and the McCormick & Baxter Superfund Facility as potential locations for natural areas, river access, and recreation (City of Portland, 2001).

In addition, the current understanding of proposed future development of the trail and natural areas in a future park at Willamette Cove is summarized below from the Trail Alignment Refinement Report (Alta Planning & Design, 2010), modified based on discussions with Metro.

- The Facility "presents a significant open space opportunity along the riverfront."
- The zoning allows for "public use and enjoyment of the waterfront" that "enhance the river's natural and scenic qualities" but also requires uses that "protect the functional values of water quality resources by limiting or mitigating the impact of development."
- The City's draft North Reach River Plan indicates that the Facility is considered a potential mitigation site and allows "ecologically sensitive" trails to the river.
- Metro and the City are developing a restoration plan that focuses on restoration of the Oregon white oak and madrone plant communities on the Facility.
- The paved trail would be developed on existing open corridors through the Facility. It would be 12 feet wide with 2-foot shoulders.
- Viewing platforms and/or soft surface trails to the water's edge could be strategically placed to control use of the site and to view scenery or wildlife.

As the property owner, Metro recognizes that the presence of hazardous substances may limit the use of the property. Therefore, Metro will agree to place restrictions on the property deeds that limit site uses to passive recreation activities (including but not limited to trails, benches, viewing areas, in-water mitigation sites), and do not allow active uses such as designated child play areas, sports fields, or picnic areas.

## 2.5 Soil Conditions

The geology beneath the Facility consists of fill and alluvial deposits. Early maps of the area indicate the current upland portion of the facility consisted of a strip of lowland adjacent to the current UPRR railroad tracks. Based on historical maps and photographs, fill was placed on this lowland and outward into the Willamette River prior to and concurrent with development. The thickness of the fill across the Facility likely varies from about 20 to 30 feet; however, in places, it could be up to 60 feet (such as in a former log pond on the West Parcel filled in the early 1970s).

The fill and alluvial deposits consist of silts and sands. These units are often distinguished from natural deposits based only on historical topographic maps and the presence of anthropogenic debris in the fill. Debris encountered in explorations at the Facility consisted mostly of bricks, metal, and wood, with lesser amounts of glass, asphalt concrete, and Portland cement concrete. In the West Parcel, debris is only present along the southern half (riverside) of the parcel at depths of up to 35 feet. In the Central Parcel, debris was present between 12 and 27 feet below the ground surface (bgs) in the western half of the parcel (surficial debris was on the east half). In the East Parcel, debris was present along the southeast perimeter, at depths of up to 15 feet (Hart Crowser, 2003).

## 2.6 Groundwater Conditions

Shallow groundwater at the Facility was measured in monitoring wells to range in depth from 23 to 37 feet bgs. Groundwater elevations ranged from 7.2 to 21.5 feet (NAVD88). Groundwater levels are expected to seasonally fluctuate in response to both precipitation and river levels, with lower groundwater elevations expected during the summer and fall. The groundwater gradient beneath the Facility is anticipated to be toward the Willamette River.

## 2.7 Surface Water Conditions

There are no surface water features or storm drains on the Facility. Precipitation either infiltrates or runs off via sheet flow.

The Willamette River is the only surface water body near the Facility. The Facility is located between River Miles 6 and 7 on the Willamette River. Along this reach, the river flows to the northwest and is about 1,500 feet wide. In Portland, the river flows at a rate ranging from 8,300 cubic feet per second (cfs) in summer to 73,000 cfs in winter. The elevation of the 100-year and 500-year floodplain along this reach is 31.2 feet and 35.2 feet, respectively (Federal Emergency Management Agency, 2010).

## 2.8 Upland Investigations and Chemicals of Concern

Numerous investigations, assessments, and environmental actions have been performed at the Facility since 1988. The following sections summarize the scope and results of work performed that are relevant to the FS. Sample locations are shown on Figures 3 through 7. Data relevant to the FS are in a spreadsheet database in Appendix B (on CD-ROM).

### *2.8.1 Remedial Investigation Soil Sampling*

The Port and Metro conducted a remedial investigation (RI) of the Facility between April 2001 and September 2002. The RI activities included completing 26 test pits, 30 direct-push soil borings, and seven hand-augered soil borings; and collecting 35 surface soil samples. The results of the RI and historical investigations were presented in the RI Report (Hart Crowser, 2003). Soil data from the RI are included in a spreadsheet database in Appendix B (on CD-ROM).

### *2.8.2 Riverbank Sampling*

DEQ provided comments on the RI Report in a letter dated December 20, 2003. Several of these comments expressed concern regarding potentially erodible soil on the riverbank at the Facility. In response to these comments and additional comments received from DEQ in meetings on June 22, 2005 and October 17, 2005, the Port and Metro completed riverbank sampling. The purpose of that work was to assess for the presence and magnitude of polychlorinated biphenyls (PCBs), PAHs, and metals in potentially erodible riverbank soil for evaluating source control for the Facility.

The results of the first phase of riverbank sampling were presented in the *Riverbank Soil Sampling Report* (BBL/Ash Creek/NF, 2006). That report presents results for samples WC-SSA through WC-SSK. These data are included in a spreadsheet database in Appendix B (on CD-ROM).

The Port and Metro conducted sampling to assess the lateral extent of PCBs in the riverbank at the boundary between the East and Central Parcels. The sampling results for additional surface soil samples (WC-SSH-A through WC-SSH-H, WC-SSH-SHS1, and WC-SSH-SHS2) were presented in the *Addendum to Riverbank Soil Sampling Results Report* (Ash Creek/NewFields, 2008). These data are included in a spreadsheet database in Appendix B (on CD-ROM).

In 2010, additional riverbank sampling was completed. Sample results (WC-SSL through WC-SSY and WC-1 through WC-3) are presented in the *2010 Source Control Sampling Results* (Ash Creek, 2011). These data are included in a spreadsheet database in Appendix B (on CD-ROM).

Follow-up sampling of soil in the vicinity of the former wharf road was completed in 2012. Sample results (DU-1, DU-2, and DU-3) are presented in the report *Surface Soil Sampling Results — Former Wharf Road Area* (Ash Creek, 2012). These data are included in a spreadsheet database in Appendix B (on CD-ROM).

### *2.8.3 Additional Upland Sampling*

Surface soil sampling was conducted in 2014 to support additional risk analysis and design of removal actions.

- In response to comments on the residual risk assessments, the Port/Metro conducted surface soil sampling for dioxins/furans and mercury (DU-4 through DU-7 series of samples). Dioxin/furan samples were collected as discrete samples, composite samples, and incremental sampling methodology (ISM) samples. Results are presented in two reports: *Incremental Surface Soil Sampling Results* (Apex, 2014a) and *Surface Soil Sampling Results – DU-6* (Apex, 2014c). These data are included in a spreadsheet database in Appendix B (on CD-ROM).
- The Port/Metro are preparing to conduct a removal action for hot spot soil. Surface soil sampling was conducted to support design of the removal action (Area-1 through Area-6 series samples). Results are presented in the report *Surface Soil Sampling – Remedial Design* (Apex, 2014b).

### *2.8.4 Chemicals of Potential Concern*

A screening of the chemical data was completed to identify chemicals of potential concern (COPCs). In general, the screening process used assumptions about exposure and toxicity that are more conservative than used in the subsequent risk calculations. This approach assures that chemicals that may contribute small but significant portions to overall risk are not left out. The COPC screening identified the following chemicals detected at least once in soil above screening levels in the upland exposure units.

| COPC | Ecological | Human Health |
|---|---|---|
| Antimony | X | X |
| Arsenic | | X |
| Cadmium | X | |
| Chromium | X | |
| Copper | X | |
| Lead | X | X |
| Mercury | X | |
| Nickel | X | |
| Zinc | X | |
| PCBs | X | X |
| Dioxins/Furans | X | X |
| Dibenzofuran | X | |
| Phthalates | X | |
| TPH | X | |
| PAHs | X | X |

## 2.9 Source Control Evaluation

A source control evaluation is underway for the Facility. A source control evaluation report (Ash Creek, 2013) was submitted to the DEQ in February 2013. DEQ provided comments in a letter dated April 15, 2014. Based on the DEQ comments, the source control evaluation will be revised and re-submitted. Regardless, the upland data used in the source control evaluation are also considered in the feasibility study, and final remedies related to upland remediation, source control, and in-water remedies will be coordinated.

# *3.0 Summary of Baseline Risk*

For the purpose of evaluating baseline risk, the Facility was divided into six exposure units. Two of these units, Central Beach Unit and Inner Cove Beach Unit, are not on the Facility. Baseline risks, if any, for these two units will be addressed by the in-water cleanup actions and are not the subject of this FS. Baseline risk for the other four units – West Parcel, Central Parcel, East Parcel, and former Wharf Road (dioxins only) – is summarized below.

## 3.1 Ecological Risk Assessment

A Level II Screening RERA was completed for the Facility (Formation, 2014a). In addition, the RERA was updated based on data collected in January through April 2014. The updated risk evaluation is included in Appendix C. Based on the results presented in the RERA and risk update, ecological receptors at the Facility could experience toxic exposures to chemicals of concern (COCs). Figures in Appendix C (on CD-ROM) show the locations of soil samples exceeding ecological Preliminary Remediation Goals (PRGs) and high concentration hot spots for each COC. Ecological PRGs and high concentration hot spot levels determined in the risk assessment and subsequent interaction with DEQ are listed in Table 1. A summary of the potential baseline risks for each exposure unit is provided below.

### *3.1.1 West Parcel*

Dioxins/furans, PCBs, high molecular weight PAHs (HPAHs), copper, lead, and mercury were detected on the West Parcel above corresponding PRGs (Figure 8). Dioxins and mercury were detected above hot spot levels (Figure 9). Dioxins/furans, copper, and mercury were detected above PRGs in the ISM sample. PCBs and HPAHs exceeded PRGs by a factor of 10 percent in discrete samples, lead exceeded the PRG by a factor of 2, and lead and HPAHs were below the PRG in the ISM sample, so the overall risk to populations from these COCs is expected to be acceptable. Primary ecological risk drivers for the West Parcel are summarized as follows.

- Mercury exceeded the PRG by 25 percent in the ISM sample and by a factor of 12 in the discrete sample, so the discrete sample location is a high concentration hot spot.

- Copper exceeded the PRG by a factor of 50 percent in the ISM sample. Discrete samples collected in the northern portion of the parcel were below PRGs.
- Dioxins/furans were detected above ecological PRGs (mammal and bird) in the ISM sample by factors of up to 25. The West Parcel is a high concentration hot spot for dioxins/furans for mammal receptors, but not birds.

### *3.1.2 Central Parcel/Former Wharf Road*

Dioxins/furans, metals (antimony, chromium, copper, lead, mercury, nickel, and zinc), PCBs, and HPAHs were detected on the Central Parcel above corresponding PRGs (Figure 8). Dioxins/furans, antimony, copper, lead, mercury, zinc, and HPAHs were detected at least once above high concentration hot spot levels (Figure 9). Chromium, nickel, and PCBs were detected above PRGs infrequently (one, six, and two samples, respectively), and the maximum PRG exceedance was less than four times, so the overall risk to populations from these COCs is expected to be acceptable. Primary ecological risk drivers for the Central Parcel are summarized as follows.

- Antimony exceeded the PRG in scattered locations. One sample exceeded the hot spot level.
- Copper exceeded the PRG by factors up to 78 in the central and eastern portions of the Central Parcel. Copper exceeded the hot spot level in four locations with the larger relative area at the eastern end of the Central Parcel.
- Lead exceeded the PRG by factors up to 94 throughout the Central Parcel. Lead exceeded the hot spot level in eight locations with the larger relative areas in the central and eastern portions of the Central Parcel.
- Mercury exceeded the PRG by factors up to 250 throughout the Central Parcel. Mercury exceeded the hot spot level in eight locations with the larger relative areas in the central portion and at the east end of the Central Parcel.
- Zinc exceeded the PRG by factors up to 12 in the central and eastern portions of the Central Parcel. Zinc exceeded the hot spot level in one sample.
- HPAHs exceeded the PRG in five locations by factors up to 58. Three of the five locations represent single samples exceeding the PRG by a factor of 2 or less. At two locations (near the wharf road and at the west end of the Central Parcel), HPAHs exceeded hot spot levels with the larger relative area at the west end of the Central Parcel.
- Dioxins/furans exceeded the PRGs throughout the Central Parcel by factors up to 11,000. The central portion of the Central Parcel and a small area near the wharf road are hot spots for mammalian and avian receptors (with the mammalian areas slightly larger than the avian).

### 3.1.3 East Parcel

Dioxins/furans, metals (antimony, chromium, copper, lead, mercury, nickel, and zinc), and PCBs were detected on the East Parcel above corresponding PRGs (Figure 8). Antimony, copper, lead, zinc, and PCBs were detected at least once above high concentration hot spot levels (Figure 9). No individual dioxin/furan congeners were detected above hot spot levels. Chromium and mercury were each detected above PRGs only once each at concentrations exceeding the PRG by 2 and 4 times, respectively, and the samples exceeding PRGs are located in areas that were identified as high concentration hot spots for other COCs. For metals and PCBs outside of hot spot areas, only nickel and zinc were detected once each above PRGs, and the PRGs were exceeded by less than 10 percent. Except for dioxins outside of the metals/PCBs hot spot areas, ecological risks on the East Parcel are acceptable. The ISM sample for the East Parcel contained dioxin congeners above PRGs and the TEQ concentration exceeded the hot spot level. Primary ecological risk drivers for the East Parcel are summarized as follows.

- Antimony exceeded the PRG by factors up to 71. Samples exceeding PRGs and hot spot levels were located along the BNSF railroad embankment. The ISM sample result was above the PRG, but the result is consistent with the relatively higher concentrations in soil along the BNSF embankment.
- Copper exceeded the PRG by factors up to 680. Samples exceeding PRGs and hot spot levels were located along the BNSF railroad embankment. Two samples above the PRG are located immediately adjacent to the border with the Central Parcel.
- Lead exceeded the PRG by factors up to 72. The ISM sample also exceeded the PRG. Lead exceeded the hot spot level in two locations: one area along the BNSF railroad embankment and the other a sample immediately adjacent to a larger hot spot area in the Central Parcel.
- Nickel exceeded the PRG by factors up to 8. Samples exceeding PRGs were generally located along the BNSF railroad embankment. One sample located away from that area exceeded the PRG by a factor of 1.3.
- Zinc exceeded the PRG by factors up to 15. The ISM sample also exceeded the PRG. Zinc exceeded the hot spot level in two samples located along the BNSF railroad embankment.
- PCBs exceeded the PRG in two locations by factors up to 79. One location was a single sample collected on the beach on the boundary between the in-water and upland sites. The other location is near the boundary with the Central Parcel. PCBs exceeded hot spot levels in both locations.
- Dioxins/furans were detected above ecological PRGs (mammal only) in the ISM sample by factors of up to 16. The East Parcel TEQ concentration was greater than 10 times the PRG for mammal receptors, but not birds.

## 3.2 Human Health Risk Assessment

Human health baseline risks are summarized below for each exposure unit from the results of the RHHRA (Formation, 2013). The following receptors were evaluated for baseline risk.

- Transient Trespasser (current): This scenario represents current exposures to trespassers that may camp (illegally) at the site for relatively short periods of time during a two-year period. The scenario applies only to adults.
- On-Site Construction Worker (future): This scenario represents individuals that may have contact with soils while building structures or conducting earthwork associated with the potential recreational development such as restrooms, walkways, and shelters. The scenario assumes relatively high contact with soils, but for time periods that are associated with short-term construction projects. The scenario applies only to adults.
- Recreational Trespasser (current)/Park User (future): This scenario represents current recreational use such as accessing the site for jogging, hiking, observing nature, or other similar passive recreational activities. Although access for these activities is currently not legal, such use is regularly observed. Under baseline conditions, it was assumed that future use of the site could include active recreational use such as playgrounds. Active recreational use is not currently planned to be allowed. The baseline scenario conservatively assumes an individual may use the site, including active recreational uses, over a lifetime. Therefore, the exposure and risk calculations assume child and adult exposures.

Figures in Appendix C (on CD-ROM) show the locations of soil samples exceeding human health PRGs and high concentration hot spots for each COC. These figures include layers that allow the user to toggle between the receptor scenarios presented above. Human health PRGs and high concentration hot spot levels determined in the risk assessment are listed in Table 2.

### *3.2.1 West Parcel*

Risks are acceptable for the Transient Trespasser and the Construction Worker. Unacceptable baseline risk was identified for the Recreational Trespasser for two PAHs, three dioxin congeners, and dioxin/furan TEQ. No human health high concentration hot spots were identified on the West Parcel. Figures 10 through 12 show the locations of areas with unacceptable human health baseline risk and areas above hot spot levels.

### *3.2.2 Central Parcel/Former Wharf Road*

Unacceptable baseline risks were identified for each receptor, as summarized below (see Figures 10 through 12).

Recreational Trespasser/Future Park User. Concentrations of multiple dioxin congeners, the dioxin/furan TEQ, arsenic, lead, antimony, and PAHs exceed Recreational Trespasser/Future Park User PRGs for the Central Parcel. Dioxin congeners at eight sample locations in the central portion of the Central Parcel exceed human health hot spot levels. Concentrations of benzo(a)pyrene (BaP) above high concentration hot spot levels are present at five sample locations. Risk from arsenic ingestion exceeded the PRG, but the arsenic concentrations in soil (2 to 40 milligrams per kilogram [mg/kg]) are similar to the default background concentration (8.8 mg/kg). Of the 16 samples that exceeded the default background concentration for arsenic, 12 are located in an area identified as an ecological or human health high concentration hot spot based on the presence of other chemicals. Antimony exceeded the PRG at only one sample location.

Construction Worker. Concentrations of multiple dioxin congeners and the dioxin/furan TEQ exceeded the Construction Worker PRGs in the Central West Parcel (DU-6). In the Central East Parcel (DU-5), the TEQ exceeded the PRG by a factor of less than 1.5, so the overall risk is expected to be acceptable except that dioxin/furan congeners exceed PRGs at the wharf road area (DU-1 through DU-3). Lead and BaP exceed Construction Worker PRGs for the Central Parcel. In the central portion of the Central Parcel, dioxin congeners exceed human health hot spot levels related to the Construction Worker.

Transient Trespasser. Concentrations of three dioxin congeners and the TEQ concentration exceed Transient Trespasser PRGs for the Central West Parcel (DU-6). Risks are acceptable for the Central East Parcel (DU-5) except that dioxin/furan congeners exceed PRGs at the wharf road area (DU-1 through DU-3). Lead (at three sample locations) and BaP (at two locations) exceed Transient Trespasser PRGs for the Central Parcel. Dioxin congeners at two sample locations on DU-6 exceed human health hot spot levels related to the Transient Trespasser.

### *3.2.3 East Parcel*

Unacceptable baseline risks were identified for each receptor, as summarized below (see Figures 10 through 12). No human health high concentration hot spots were identified on the East Parcel.

Recreational Trespasser/Future Park User. Several dioxin congeners are at or slightly above PRGs (exceed PRGs by less than a factor of 2), and the dioxin/furan TEQ exceeds the PRG by a factor of 5. Antimony, arsenic, lead, BaP, and PCBs each exceed PRGs. The samples contributing most to the unacceptable risk are located along the BNSF railroad embankment in an area identified as an ecological high concentration hot spot.

Construction Worker. Lead, antimony, and PCBs were detected above PRGs. The samples with metals contributing to the unacceptable risk are located along the BNSF railroad embankment in an area identified as an ecological high concentration hot spot. The sample with PCBs is on the beach on the border between the in-water site and upland facility.

**Transient Trespasser.** Lead is present above PRGs in one out of 25 samples by a factor of less than three. Based on the infrequent detection above the PRG, risks for the Transient Trespasser are considered acceptable. The sample exceeding the PRG is located along the BNSF railroad embankment in an area identified as an ecological high concentration hot spot.

# 4.0 Site Model

Based on the information summarized in Sections 2 and 3, this section presents the overall site model that is the basis for the evaluations completed in the FS.

## 4.1 Nature and Extent of Contamination

This section summarizes the nature and extent of contamination on the Facility as it relates to potential risk and the potential receptors. Figures 13 through 15 summarize the locations of potential cleanup areas and hot spot areas. The various areas shown on the figure were determined by defining each locus of sampling points where soil data exceeded a PRG corresponding to an unacceptable baseline risk pathway or a hot spot level (as shown on Figures 8 through 12). The data are included in a spreadsheet database in Appendix B (on CD-ROM) and the PRGs are shown in Tables 1 and 2.

### *4.1.1 West Parcel*

Unacceptable ecological risk is present resulting from primarily dioxins/furans and mercury (Figure 13). Copper and mercury were detected in the ISM sample at slightly above the PRG. Mercury is present above the high concentration hot spot level at one location. The West Parcel is above the hot spot level for one dioxin congener based on the ISM sample (Figure 15).

Figure 14 summarizes human health risk areas. Baseline human health risk is acceptable on the West Parcel for short-term or passive uses (e.g., construction, transient visitors, animal watching). For more active uses such as picnicking or athletics, baseline risks are unacceptable as a result of PAHs and dioxins/furans in surface soil (0 to 3 feet in depth). There are no human health hot spots on the West Parcel (Figure 15).

### *4.1.2 Central Parcel/Former Wharf Road*

Ecological receptors on the Central Parcel could experience toxic exposures to dioxins/furans, metals, and PAHs in surface soil (Figure 13). Outside of hot spot areas as shown on Figure 15, average concentrations of metals and PAHs exceed PRGs by factors of less than two (see residual risk discussion in Section 10.3). Based on the ISM sampling, the dioxin/furan TEQ for the Central Parcel exceeds the PRG by greater than 10 times.

Baseline human health risk is unacceptable on the Central Parcel (Figure 14). Active uses exceed the acceptable risk levels throughout the parcel resulting from exposure to dioxins/furans and PAHs (and exposure to arsenic and lead in the central area, and exposure to arsenic in the eastern area). One small area near the west end exceeds acceptable risk levels for passive uses and construction workers resulting from exposure to PAHs. The central portion of the Central Parcel also has unacceptable risk for passive uses and construction workers as a result of dioxins/furans and lead. The eastern portion of the Central Parcel has unacceptable risk for construction workers as a result of dioxins/furans. The wharf road area has unacceptable risk for passive uses and construction workers as a result of dioxins/furans and PAHs (and lead for the construction worker). Figure 15 shows human health hot spots. PAH hot spots are located at the west end and near the wharf road. A dioxin/furan hot spot is located in the central portion of the parcel.

### *4.1.3 East Parcel*

Dioxins/furans, lead, and zinc are present above ecological PRGs on the East Parcel (Figure 13). Along the BNSF railroad embankment, multiple metals exceed PRGs and hot spot levels (Figure 15). Outside of hot spot areas as shown on Figure 15, only one sample each for lead and zinc exceeded PRGs (by factors of 1.3 or less). Two small areas along the shoreline exceed PRGs and hot spot levels for PCBs. The dioxin/furan TEQ concentration exceeds the PRG by a factor of greater than 10 for the ISM sample.

Except for three small areas with construction worker risk (lead at the border with the Central Parcel; PCBs on the beach; and metals along the BNSF railroad embankment), baseline human health risk is acceptable on the East Parcel for short-term or passive uses (e.g., construction, transient visitors, animal watching). For more active uses such as picnicking or athletics, baseline risks are unacceptable primarily as a result of dioxins/furans and BaP. There are no human health hot spots on the East Parcel.

## 4.2 Existing Conditions

Most of the Facility is flat with relatively good access. The primary exceptions are the riverbank and the embankment along the BNSF railroad. The riverbank is relatively steep and much of the bank is covered with riprap. A narrow strip of the Facility property runs along the base of the BNSF embankment and is bordered by the cove beach on one side and the steep embankment on the other.

Except for some remnant concrete foundations and limited paved areas, the Facility is vacant and reverting to natural conditions. The summary of vegetation communities in Appendix A shows that approximately one-third of the Facility is covered with hardwood forest that is targeted by the City and Metro for restoration. The remainder of the Facility is primarily scrub/shrub or meadow plant communities. The east end of the Central Parcel contains an area of non-native, ornamental landscape plants.

## 4.3 Site Use

Based on multiple factors such as property ownership, zoning, and government plans, the property is targeted for green space, ecological restoration, and park uses consistent with green spaces. Although some planning documents included consideration of more active recreational uses (e.g., picnicking), the property owner (Metro) understands that active recreational uses may not be suitable for the Facility and that deed restrictions could be required to limit site uses. The most specific discussion of future site use includes restoration of natural areas (creating ecological habitat), pathways, and passive recreational uses such as viewing of scenery and bird watching.

## 4.4 Coordination with Other Portland Harbor Activities

This FS addresses cleanup of the upland Facility at Willamette Cove. Other activities associated with the Portland Harbor cleanup may include source control, in-water cleanup, and habitat restoration. These are briefly discussed below as they relate to potential upland cleanup options.

Source Control. The source control evaluation is underway. Preliminary results suggest that a portion of the Facility riverbank will require source control action. A source control remedy has not been identified but could include removal or bank stabilization. Evaluation of upland remedial options includes consideration of potential source control actions.

In-Water Cleanup. The Portland Harbor FS is evaluating potential remedial alternatives for in-water cleanup. Potential remedies include dredging, various types of caps, *in situ* treatment, and several approaches to natural recovery. These potential in-water remedies will be factored into the evaluation of upland remedial actions.

Habitat Restoration. Restoration of the habitat along the Willamette Cove riverbank is likely. A riverbank restoration plan would likely include elements such as removal of riprap, removal of remnant pilings and other debris, flattening of the riverbank slope, removal of invasive species, and restoration of native vegetation. All or a portion of many of the high concentration hot spot areas at the Facility are on or near the riverbank and would likely be within areas targeted for restoration. These potential restoration activities will be factored into the evaluation of upland remedial actions.

# *5.0 Remedial Action Objectives and Evaluation Criteria*

RAOs are medium-specific goals for protecting human health and the environment and provide the framework for developing and evaluating remedial action alternatives. RAOs were developed to address pathways that pose the potential for unacceptable risk and to remediate hot spots to the extent feasible. RAOs for the Facility are presented below.

## 5.1 Remedial Action Objectives

The following RAOs have been identified for the Facility.

### 5.1.1 Ecological

Table 1 lists the ecological COCs together with the concentrations corresponding to adverse impact to individuals and high concentration hot spots. Ecological receptors include plants, invertebrates, birds, and mammals. The following lists the specific RAOs for ecological receptors.

- Prevent exposure of ecological receptors to surface soil containing COCs above the levels in Table 1 (see Figure 13).
- Remove or treat hot spots to the extent practicable as defined by DEQ rules (see Figure 15).

### 5.1.2 Human Health

Table 2 lists the human health COCs together with the concentrations corresponding to adverse impact to receptors and high concentration hot spots. The following lists the specific RAOs for human receptors.

- Prevent active recreational exposure to surface soil on the West Parcel.
- Prevent exposure of active/passive recreational users and construction workers to surface soil on the Central Parcel (see Figure 14).
- On the East Parcel:
    - Prevent active recreational exposure to surface soil (see Figure 14).
    - Prevent construction worker exposure to the potential cleanup area on the BNSF railroad embankment (see Figure 14).
- Remove or treat hot spots to the extent practicable as defined by DEQ rules (see Figure 15).

## 5.2 Evaluation Criteria

The evaluation of potentially feasible alternatives was based on the following criteria (OAR 340-122-085(4)).

### 5.2.1 Protectiveness

Protectiveness is a threshold requirement; only alternatives that meet the protectiveness requirements were evaluated (OAR 340-122-040). The protectiveness standards are:

- Ability of remedial action to protect present and future public health, safety, and welfare;
- Ability of remedial action to achieve acceptable risk levels specified in OAR 340-122-115;

- Ability of remedial action to prevent or minimize future releases and migration of hazardous substances in the environment; and
- Requirements for long-term monitoring, operation, maintenance, and review.

### *5.2.2 Balancing Factors*

Balancing Factors include the following (OAR 340-122-090(3)):

- Effectiveness: Ability and timeframe of remedial action to achieve protection through eliminating or managing risk;
- Long-Term Reliability: Reliability of remedial action to eliminate or manage risk and associated uncertainties;
- Implementability: Ease or difficulty of implementing a remedial action considering technical, mechanical, and regulatory requirements; this will include evaluation of compatibility of the remedy with potential future source control actions, in-water remedies, and habitat restoration;
- Implementation Risk: Potential impacts to workers, the community, and the environment during implementation, including consideration of DEQ and EPA green remediation policies; and
- Reasonableness of Costs: Considers capital costs, operations and maintenance, and periodic review, and includes a net present-value evaluation of the remedial action.

### *5.2.3 Treatment or Removal of Hot Spots*

Hot spots are evaluated based on the feasibility of treatment/removal of the hot spot using the above balancing factors with a higher threshold for cost reasonableness (OAR 340-122-085(5,6,7), -090(4)). Consistent with DEQ rules, the higher threshold is applied only as long as the hot spot exists.

# *6.0 Remedial Action Area and Extent*

The extents of soil impacted by COCs at concentrations that exceed the respective PRGs and hot spot levels are shown on Figures 13 through 15 and described in Section 4.1. This section quantifies the areas and volumes of impact that are used in the FS. Section 6.1 presents a preliminary practicability evaluation for removal/treatment of dioxin/furan hot spots. Section 6.2 lists impacted areas and volumes.

## 6.1 Preliminary Evaluation of Hot Spot Removal

Under a conservative interpretation of the hot spot rule, the DEQ required consideration of hot spots based on dioxin/furan TEQ concentrations. Using that approach, most or all of the Facility exceeds ecological hot spot levels for dioxins/furans. The feasibility of removal of hot spots is evaluated in this FS by including alternatives that include no, partial, or total removal of the hot spots. To identify an appropriate mid-range hot-spot removal alternative, a practicability evaluation was completed to quantitatively assess the point at which the cost for additional dioxin/furan hot spot removal is no longer proportionate to the benefits. The practicability evaluation is included in Appendix D. The results of the evaluation indicate that a practicable dioxin/furan hot spot remediation level is 1,000 nanograms per kilogram (ng/kg) TEQ. This remediation level encompasses the human health hot spots and generally corresponds to the ecological hot spots identified based on individual congeners.

## 6.2 Summary of Impacted Areas and Volumes

The spatial characteristics of the remedial action area are summarized as follows:

- West Parcel
  - Exceeding PRGs (entire parcel):
    - Area: 210,000 square feet (sf)
    - Thickness: 1 to 3 feet
    - Volume: 8,000 to 23,000 cubic yards (cy)
    - Mass: 14,000 to 42,000 tons (assuming 1.8 tons per cy)
  - Dioxin/furan hot spot (same as above)
  - Dioxin/furan remediation level of 1,000 ng/kg:
    - Area: 0 sf
  - Mercury hot spot:
    - Area: 400 sf
    - Thickness: 1 to 3 feet
    - Volume: 15 to 45 cy
    - Mass: 30 to 80 tons (assuming 1.8 tons per cy)
- Central Parcel:
  - Exceeding PRGs (entire parcel):
    - Area: 430,000 sf
    - Thickness: 1 to 3 feet
    - Volume: 16,000 to 48,000 cy
    - Mass: 29,000 to 86,000 tons (assuming 1.8 tons per cy)
  - Dioxin/furan hot spot (same as above)

- Dioxin/furan remediation level of 1,000 ng/kg:
    - Area: 70,000 sf
    - Thickness: 1 to 3 feet
    - Volume: 2,600 to 7,800 cy
    - Mass: 4,700 to 14,000 tons (assuming 1.8 tons per cy)
- Other hot spots[1] (outside dioxin/furan remediation level of 1,000 ng/kg):
    - Area: 66,000 sf
    - Thickness: 1 to 3 feet
    - Volume: 2,400 to 7,300 cy
    - Mass: 4,400 to 13,000 tons (assuming 1.8 tons per cy)

- East Parcel:
  - Exceeding PRGs (entire parcel):
    - Area: 340,000 sf
    - Thickness: 1 to 3 feet
    - Volume: 13,000 to 38,000 cy
    - Mass: 23,000 to 68,000 tons (assuming 1.8 tons per cy)
  - Dioxin/furan hot spot (same as above)
  - Dioxin/furan remediation level of 1,000 ng/kg:
    - Area: 0 sf
  - Other hot spots:
    - Area: 14,000 sf
    - Thickness: 1 to 3 feet
    - Volume: 520 to 1,600 cy
    - Mass: 930 to 2,800 tons (assuming 1.8 tons per cy)

[1] PAHs, antimony, copper, lead, mercury, and zinc.

# 7.0 Remedial Action Alternatives and Preliminary Screening

This section describes the development of the remedial action alternatives to be evaluated. The alternative development process includes identifying general response actions and corresponding technologies, screening technologies to eliminate technologies that are clearly not feasible, and assembling remaining technologies into a list of site-specific cleanup action alternatives. This evaluation addresses the cleanup of impacted shallow soil because it is the only medium with identified unacceptable baseline risk.

Initially, technologies associated with a list of general response actions were screened for applicability based on site and soil conditions and contaminant type. General response actions are broad categories of remedial measures that address the RAOs. Technologies and corresponding response actions may be stand-alone remedial action alternatives or a component of a comprehensive alternative. The list of general response actions includes:

- No Action;
- Institutional/Engineering Controls;
- Removal;
- Containment;
- *In Situ* Biological Treatment;
- *In Situ* Physical/Chemical/Thermal Treatment;
- *Ex Situ* Biological Treatment; and
- *Ex Situ* Physical/Chemical/Thermal Treatment.

## 7.1 Technology Screening

Table 3 provides a screening of the general response actions together with representative remedial action technologies for soil. Based on site use and type and extent of contaminants, these remedial action technologies were screened to identify a list of technologies to include in a more detailed evaluation of potential remedial action alternatives. The results of the screening are shown in Table 3, with the shaded technologies eliminated from further consideration. Comments on the table explain the rationale for eliminating technologies from further consideration. Technologies remaining for further evaluation after the initial screening are listed below.

| General Response Action | Technology |
|---|---|
| No Action | No Action |
| Institutional Controls | Deed Restrictions/Soil Management Plan<br>Monitoring |
| Engineering Controls | Access Restrictions |
| Containment | Capping |
| Removal and Disposal | Excavation<br>Off-Site Disposal<br>On-Site Disposal |
| *In Situ* Treatment | Immobilization |
| *Ex Situ* Physical Treatment | Solidification/Stabilization<br>Separation |

## 7.2 Development of Cleanup Action Alternatives

Supporting or Supplemental Technologies. Several of the technologies retained for evaluation are only suitable for use in conjunction with other technologies and would not be considered as standalone alternatives. Several of these technologies are applicable only if used in conjunction with other technologies and have been retained as Supporting Technologies, and several of the technologies may only be applicable if they are deemed appropriate during implementation of the potential cleanup alternatives as Supplemental Technologies. The Supporting and Supplemental Technologies are listed below.

| Supporting Technologies | Supplemental Technologies |
|---|---|
| Soil Management Plan and Deed Restrictions | Solidification/Stabilization |
| Monitoring | Separation |
| Access Restrictions | |
| Off-Site Disposal | |
| On-Site Disposal | |
| Immobilization | |

Cleanup Action Alternatives for Soil. The applicable primary, stand-alone cleanup technologies for soils include capping and excavation. These technologies are incorporated into cleanup action alternatives with the Supporting Technologies. The cleanup action alternatives for soil, therefore, include the following.

- Alternative 1: No Action – This alternative is retained for comparison with other remedial action alternatives listed below.
- Alternative 2: Cap – This alternative includes capping of the impacted soils using soil or pavement to prevent direct contact with or migration of impacted soil. Contaminated soils are not removed via capping and given the site contaminants, it is reasonable to assume that minimal degradation will occur. As such, implementation of engineering controls, such as signage to restrict access to

areas of the site, and institutional controls, in the form of deed restrictions and a soil management plan (SMP), will be required. Routine, long-term cap maintenance inspections will be necessary in perpetuity. This alternative represents a conservative approach that results in no restrictions on the type of receptors that may use the site but requires long-term site management.

- Alternative 3: Excavation and Off-Site Disposal – This alternative includes the complete removal of impacted soils from the site to a licensed landfill. Depending on the waste designation, the soil would be disposed of in a Subtitle D or C landfill. Alternatively, hazardous wastes could be treated to non-hazardous conditions (e.g., through stabilization) prior to disposal in a Subtitle D landfill. Following excavation, the site would be backfilled with clean soil or re-graded using existing site soil. Continued monitoring would not be necessary. Separation technologies could be used to separate rock and debris from contaminated soil, reducing the amount of material disposed of in a landfill. This alternative represents a conservative approach that results in no site use restrictions.
- Alternative 4: Excavation and On-Site Disposal – This alternative includes excavation of impacted soil and consolidating the soil in an on-site landfill. Selected areas could also be capped in place as part of the on-site landfill. Depending on the waste designation, the soil would be treated to non-hazardous conditions (e.g., through stabilization) prior to disposal. Alternatively, hazardous wastes, if any, could be disposed of off-site in a Subtitle C landfill with the remaining soil placed in the on-site landfill. As with the capping only alternative, implementation of secondary technologies associated with capping would also need to be implemented and long-term cap inspections would be necessary. Separation technologies could be used to separate rock and debris from contaminated soil, reducing the amount of material disposed beneath the cap. This alternative is primarily intended to allow comparison of off-site and on-site disposal.
- Alternative 5: Excavation and On-Site/Off-Site Disposal – This alternative includes excavation of impacted soil with higher concentrations of COCs (non-dioxin/furan hot spots plus areas exceeding the dioxin/furan remediation level) for off-site disposal and consolidating the remaining soil in an on-site landfill. Selected areas could also be capped in place as part of the on-site landfill. Depending on the waste designation, the soil would be treated to non-hazardous conditions (e.g., through stabilization) prior to disposal. Alternatively, hazardous wastes, if any, could be disposed of in a Subtitle C landfill. As with the capping only alternative, implementation of secondary technologies associated with capping would also need to be implemented and long-term cap inspections would be necessary. Separation technologies could be used to separate rock and debris from contaminated soil, reducing the amount of material disposed.
- Alternative 6: Focused Excavation and Off-Site Disposal with Cap – This alternative includes excavation of impacted soil with higher concentrations of COCs (non-dioxin/furan hot spots plus areas exceeding the dioxin/furan remediation level) for off-site disposal and capping remaining areas of impacted soil. Depending on the waste designation, the soil would be treated to non-hazardous conditions (e.g., through stabilization) prior to disposal. As with the capping only alternative, implementation of secondary technologies associated with capping (engineering and

institutional controls) would also need to be implemented and long-term cap inspections would be necessary. This alternative will facilitate evaluation of the feasibility of at least partial removal of hot spots.

- Alternative 7: Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction – This alternative includes excavation of impacted soil from non-dioxin/furan hot spot areas and areas within the dioxin/furan remediation level for off-site disposal. Depending on the waste designation, the soil would be treated to non-hazardous conditions (e.g., through stabilization) prior to disposal. The remaining areas would be covered with a thin soil cap with amendments to address ecological risk through short-term reduction in direct contact risk, reducing bioavailability, and by enhancing natural recovery through mixing with native soils. Human health risks would be addressed through access restrictions (signage), engineering controls during any construction work, and deed restrictions on site uses. This alternative combines conservative approaches to the extent practicable for hot spots with cost-effective but protective approaches to address human and ecological risk.
- Alternative 8: Alternate Cap and Access Restriction – This alternative includes the placement of a thin soil cap over areas of unacceptable risk to address ecological risk through short-term reduction in direct contact risk, reducing bioavailability, and by enhancing natural recovery through mixing with native soils. Human health risks would be addressed through access restrictions (signage), engineering controls during any construction work, and deed restrictions on site uses. This alternative is a relatively low-cost alternative that is still protective to compare to the more costly and conservative approaches.

These alternatives are evaluated in detail in Section 8.

# 8.0 Detailed Analysis of Remedial Action Alternatives

This section describes and evaluates each of the remedial action alternatives identified in Section 7. Feasibility of the alternatives was evaluated using the criteria in Section 5.2.

Following the evaluation, a comparative analysis of each alternative relative to the other alternatives was completed (Section 9). The comparative analysis serves as the basis for selecting the recommended remedial action alternative (Section 10).

## 8.1 Alternative 1 – No Action

**Description.** According to OAR 340-122-085(2), a No Action alternative must be evaluated as a remedial action alternative. The No Action alternative assumes that no action is taken, no monitoring is performed, and no costs are incurred.

**Protectiveness.** The No Action alternative is not protective because it allows contaminants to be left in place at concentrations that exceed protective levels as determined from the baseline risk assessment.

**Effectiveness.** The No Action alternative does not effectively manage or eliminate risk.

**Long-Term Reliability.** The No Action alternative is not reliable because it does not manage or eliminate risk.

**Implementability.** The No Action alternative is the easiest of the alternatives to implement.

**Implementation Risk.** Since there are no construction or remediation activities associated with the No Action alternative, there is no risk to workers or the public during implementation of this alternative.

**Reasonableness of Cost.** There is no cost associated with the No Action alternative.

**Treatment or Removal of Hot Spots.** This alternative does not treat or remove the hot spots.

## 8.2 Alternative 2 – Cap

**Description.** For this alternative, the baseline risk would be managed with an engineered cap to prevent direct contact by both human and ecological receptors. Figure 16 shows the proposed cap area, and Figure 17 is a representative cap cross-section (Detail A). In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or reused on-site as mulch. Roots and other debris below the ground surface would remain. One to two feet of clean, imported fill would be placed and the surface would be finished with native grasses, shrubs, and trees. The final cap thickness would be determined based on evaluation of mixing as a consequence of burrowing animals. A temporary irrigation system would be required for at least the first growing season. The cap would cover a total area of approximately 980,000 square feet for a total quantity of 36,000 to 73,000 cubic yards (60,000 to 120,000 tons).

Along the riverbank, cap construction would need to be coordinated with source control, habitat enhancement, and/or in-water remedial actions. Figure 18 shows a typical conceptual cross-section of the riverbank construction (Detail D). In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. The excavated soil would be placed upland, beneath the cap. The cap would extend down the riverbank, if needed, based on verification sampling of the excavated area. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail may be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, cap inspection/repair, plant inspection and replacement, herbivore control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

Institutional and engineering controls, including an SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the cap and contamination would be required.

Capped areas could be developed for passive or active recreational use as discussed in planning documents. Other uses would also be possible provided that those uses are compatible with the presence of the cap and the associated restrictions.

Protectiveness. The cap alternative is protective of human and ecological receptors by preventing direct contact with soil containing COCs. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

Effectiveness. Capping is a very effective means to address risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. None of the COC mass would be removed from the site. Long term, there would be some mixing of cap and underlying soils resulting from activity of burrowing mammals. Except potentially in hot spot areas, the resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs (a thicker cap may be required in hot spot areas). Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to construct and it would be protective immediately after implementation.

Long-Term Reliability. The long-term reliability of this alternative requires maintenance of the cap, engineering and institutional controls, and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 4,800 to 9,700 truck trips through the neighborhood, assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. The cap area could be decreased as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

**Implementation Risk.** Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 4,800 to 9,700 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – Much of the Facility is covered with native plant communities, including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the soil borrow source is located within 10 miles of the site, the project would generate approximately 48,000 to 97,000 truck miles.

**Reasonableness of Cost.** Tables 4a and 4b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of net present value (NPV), assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents cap thicknesses of 1 to 2 feet).

| | |
|---|---|
| Capital | $ 3,040,000 to 4,380,000 |
| Long-Term (NPV) | $ 220,000 to 260,000 |
| Contingency | $ 490,000 to 700,000 |
| Total (NPV) | $ 3,750,000 to 5,340,000 |

**Treatment or Removal of Hot Spots.** This alternative does not treat or remove hot spots.

## 8.3 Alternative 3 – Excavation and Off-Site Disposal

### *8.3.1 Alternative 3a – Standard Excavation*

**Description.** For this alternative, soil in the hot spot and cleanup areas would be excavated and disposed of in an off-site landfill. The final depth of excavation would be based on verification sampling, but a depth of 1 to 3 feet is assumed. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal in a Subtitle D landfill; otherwise, hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the PRGs or hot spot levels.

Figure 16 shows the proposed excavation area, and Figure 17 is a representative excavation cross-section (Detail H). In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or re-used on-site as mulch. Roots and other debris below the ground surface would be excavated with the soil. Soil would be excavated throughout the cleanup area using standard construction equipment. Following excavation, one foot of clean, imported topsoil would be placed and the surface would be finished with native grasses, shrubs, and trees. A temporary irrigation system would be required for at least the first growing season. The total area of the excavation would be approximately 980,000 square feet for a total quantity of 36,000 to 109,000 cubic yards (65,000 to 200,000 tons). The foot of topsoil would cover a total area of approximately 980,000 square feet for a total quantity of 36,000 cubic yards (58,000 tons).

Along the riverbank, the construction would need to be coordinated with source control, habitat restoration, and/or in-water remedial actions. Figure 18 shows a typical conceptual cross-section of the riverbank construction (Detail E). In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. Riprap would be excavated separately or the soil would be passed through a screen to separate rock from soil disposed of off-site. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail may be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Once the vegetation is established, no long-term inspection or maintenance would be required.

There would be no institutional or engineering controls.

Site use would be unrestricted.

**Protectiveness.** Landfill disposal achieves protection by removing the contaminated soil to a managed facility. Except for irrigation and plant maintenance during the first few years, there are no long-term monitoring, operations, or maintenance requirements.

**Effectiveness.** This alternative is effective because the impacted soil is removed off-site to a controlled landfill. The alternative is estimated to require six to 12 months to construct and it would be protective immediately after implementation.

**Long-Term Reliability.** Disposing of the soil at a landfill will eliminate the human health and ecological risks from the soil by removing the contaminant source to a managed facility. This alternative otherwise has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring.

**Implementability.** This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 9,600 to 19,000 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. Excavation is generally compatible with any potential source control action, in-water remedy, or habitat restoration. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

**Implementation Risk.** Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 9,600 to 19,000 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – Much of the Facility is covered with native plant communities, including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 190,000 to 480,000 truck miles.

**Reasonableness of Cost.** Tables 5a and 5b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents excavation depths of 1 to 3 feet).

| | |
|---|---|
| Capital | $7,160,000 to 14,840,000 |
| Long-Term (NPV) | $ 190,000 |
| Contingency | $ 1,100,000 to 2,250,000 |
| Total (NPV) | $8,450,000 to 17,280,000 |

Treatment or Removal of Hot Spots. This alternative addresses the hot spots by complete removal to a controlled landfill.

### *8.3.2 Alternative 3b – Alternative Excavation*

Description. This alternative is the same as Alternative 3a except that excavation techniques would be revised to save designated native trees. Within the drip line of designated trees, low impact excavation techniques, such as hand or vacuum excavation, would be used to remove soil to the maximum extent practicable without damaging the trees. The presumed excavation depth within the tree drip lines is 1 foot. Excavation would be conducted in consultation with an arborist so as to not endanger the trees. Outside of these areas, soil would be excavated using standard construction equipment to depths of 1 to 3 feet, as determined by verification sampling. Following excavation, one foot of imported topsoil would be placed. The remainder of the alternative would be the same as Alternative 3a. The layout and details for this alternative are shown on Figures 16, 17 (Detail I), and 18 (Detail E).

As discussed in Section 4.2, one-third of the area is covered by trees to be saved. The total area of the standard and alternative excavation would be approximately 650,000 and 330,000 square feet, respectively. Corresponding quantities are 36,000 to 84,000 cubic yards of excavation (65,000 to 152,000 tons) and 36,000 cubic yards of imported topsoil (58,000 tons). Of the total excavation, 12,000 cubic yards (22,000 tons) would be excavated using alternative techniques.

If complete removal of soil above PRGs is not possible from within the tree drip lines, institutional and engineering controls, including an SMP, signage, and designated pathways may be needed indefinitely. A deed restriction identifying the presence of the contamination would be required. Long-term annual inspection/maintenance would be required thereafter.

If complete removal is achieved, there would be no institutional or engineering controls and site use would be unrestricted.

Protectiveness. Landfill disposal achieves protection by removing the contaminated soil to a managed facility. Except for irrigation and plant maintenance during the first few years, there are no substantive long-term monitoring, operations, or maintenance requirements.

**Effectiveness.** This alternative is effective because the impacted soil is removed off-site to a controlled landfill. The alternative is estimated to require six to 12 months to construct and it would be protective immediately after implementation.

**Long-Term Reliability.** Disposing of the soil at a landfill will eliminate the human health and ecological risks from the soil by removing the contaminant source to a managed facility. This alternative otherwise has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring.

**Implementability.** This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 9,600 to 16,000 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would protect these trees. Excavation is generally compatible with any potential source control action, in-water remedy, or habitat restoration. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

**Implementation Risk.** Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 9,600 to 16,000 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – This alternative would carry low risk to native plant communities. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 190,000 to 380,000 truck miles.

**Reasonableness of Cost.** Tables 6a and 6b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents excavation depths of 1 to 3 feet).

| | |
|---|---|
| Capital | $ 8,170,000 to 13,420,000 |
| Long-Term (NPV) | $ 190,000 |
| Contingency | $ 1,260,000 to 2,040,000 |
| Total (NPV) | $ 9,620,000 to 15,650,000 |

Treatment or Removal of Hot Spots. This alternative addresses the hot spots by complete removal to a controlled landfill.

## 8.4 Alternative 4 – Excavation and On-Site Disposal

Description. For this alternative, soil in the hot spot and cleanup areas would be excavated and disposed of in an on-site landfill. The final depth of excavation would be based on verification sampling, but a depth of 1 to 3 feet is assumed. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal; otherwise hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the PRGs or hot spot levels.

Figure 19 shows the proposed excavation and landfill area (dimensions of approximately 250 by 875 feet). Figure 17 presents representative excavation (Detail H) and cap (Detail B) cross-sections. In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or re-used on-site as mulch. Roots and other debris below the ground surface would be excavated with the soil. Following excavation, outside the landfill area, one foot of clean, imported topsoil would be placed and the surface would be finished with native grasses, shrubs, and trees. The landfill area would be covered with one to two feet of soil and vegetated. The final cap thickness would be determined based on evaluation of mixing as a consequence of burrowing animals. A temporary irrigation system would be required for at least the first growing season. The total area of the excavation would be approximately 700,000 square feet (total area less the landfill footprint) for a total quantity of 26,000 to 78,000 cubic yards (47,000 to 140,000 tons). One foot of topsoil would cover a total area of approximately 700,000 square feet for a total quantity of 26,000 cubic yards (42,000 tons). The one- to two-foot landfill cap would cover a total area of approximately 280,000 square feet for a total quantity of 10,000 to 21,000 cubic yards (18,000 to 35,000 tons).

Along the riverbank, the construction would need to be coordinated with source control, habitat restoration, and/or in-water remedial actions. Figure 18 shows a typical conceptual cross-section of the riverbank construction (Detail E). In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. Riprap would be excavated separately or the soil would be passed through a screen to separate rock from soil disposed of on site. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail may be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, cap inspection/repair, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

For the landfill area, institutional and engineering controls including an SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the cap and contamination would be required.

The capped area could be developed for passive or active recreational use as discussed in planning documents. Other uses would also be possible provided that those uses are compatible with the presence of the cap and the associated restrictions. Outside the capped area, site use would be unrestricted.

**Protectiveness.** On-site disposal achieves protection by removing the contaminated soil to a consolidated area that can be capped and maintained efficiently. In the capped area, signs, deed restrictions, and the SMP would assure this protectiveness in the long term. Outside the capped area, except for irrigation and plant maintenance during the first few years, there are no long-term monitoring, operations, or maintenance requirements.

**Effectiveness.** For much of the site, this alternative is effective because the impacted soil is removed to a controlled, on-site landfill. Capping of the landfill area is a very effective means to address risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. None of the COC mass would be removed from the site. Long term, there would be some mixing of cap and underlying soils resulting from activity of burrowing mammals. The resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to construct and it would be protective immediately after implementation.

**Long-Term Reliability.** The long-term reliability of this alternative requires maintenance of the cap, engineering and institutional controls, and enforcement of the SMP. Consolidating the material in one location on-site improves the long-term reliability relative to capping. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk.

**Implementability.** This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 4,800 to

6,300 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. Construction of a large on-site landfill is likely to be less accepted by the community than removal or on-site capping. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. Excavation is generally compatible with any potential source control action, in-water remedy, or habitat restoration. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

Implementation Risk. Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 4,800 to 6,300 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – Much of the Facility is covered with native plant communities including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the soil borrow source is located within 10 miles of the site, the project would generate approximately 48,000 to 63,000 truck miles.

Reasonableness of Cost. Tables 7a and 7b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents excavation depths of 1 to 3 feet and cap thicknesses of 1 to 2 feet).

| | |
|---|---|
| Capital | $ 4,190,000 to 6,300,000 |
| Long-Term (NPV) | $ 270,000 to 310,000 |
| Contingency | $ 670,000 to 990,000 |
| Total (NPV) | $ 5,130,000 to 7,600,000 |

Treatment or Removal of Hot Spots. This alternative does not treat or remove the hot spots from the Facility. The hot spot soils are consolidated in one location, reducing the overall area of the hot spots.

## 8.5 Alternative 5 – Excavation and On-Site/Off-Site Disposal

Description. For this alternative, soil in the non-dioxin/furan hot spot areas and soil exceeding the dioxin/furan remediation level would be excavated and disposed of in an off-site landfill. Remaining soil would be excavated and disposed of in an on-site landfill. Excavation would be conducted using standard construction equipment. The final depth of excavation would be based on verification sampling, but a depth of 1 to 3 feet is assumed. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal; otherwise hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the PRGs or hot spot levels.

Figure 19 shows the proposed excavation and landfill area (dimensions of approximately 250 by 875 feet). Figure 17 presents representative excavation (Detail H) and cap (Detail B) cross-sections. In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or re-used on-site as mulch. Roots and other debris below the ground surface would be excavated with the soil. Following excavation, outside the landfill area, one foot of clean, imported topsoil would be placed and the surface would be finished with native grasses, shrubs, and trees. The landfill area would be covered with one to two feet of soil and vegetated. The final cap thickness would be determined based on evaluation of mixing as a consequence of burrowing animals. A temporary irrigation system would be required for at least the first growing season. The total area of the excavation would be approximately 740,000 square feet (total area less the landfill footprint plus hot spots within the landfill footprint) for a total quantity of 27,000 to 82,000 cubic yards (49,000 to 150,000 tons). Of that total, 5,500 to 17,000 cubic yards (10,000 to 30,000 tons) would be disposed of off-site and the remaining total would be placed in the on-site landfill. One foot of topsoil would cover a total area of approximately 700,000 square feet for a total quantity of 26,000 cubic yards (42,000 tons). The one- to two-foot landfill cap would cover a total area of approximately 280,000 square feet for a total quantity of 10,000 to 21,000 cubic yards (18,000 to 35,000 tons).

Along the riverbank, the construction would need to be coordinated with source control, habitat restoration, and/or in-water remedial actions. Figure 18 shows a typical conceptual cross-section of the riverbank construction (Detail E). In general, the riverbank would be excavated to reduce the slope to not greater than 3H:1V. Riprap would be excavated separately or the soil would be passed through a screen to separate rock from soil disposed of on site. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail may be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, cap inspection/repair, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

For the landfill area, institutional and engineering controls including an SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the cap and contamination would be required.

The capped area could be developed for passive or active recreational use as discussed in planning documents. Other uses would also be possible provided that those uses are compatible with the presence of the cap and the associated restrictions. Outside the capped area, site use would be unrestricted.

**Protectiveness.** This alternative is protective of human and ecological receptors by preventing direct contact with soil containing COCs through a combination of removal of higher relative concentration material and consolidating remaining material that can be capped and maintained efficiently. The higher relative concentration materials would be removed from the site to a controlled landfill. In the capped area, signs, deed restrictions, and the SMP would assure this protectiveness in the long term. Outside the capped area, except for irrigation and plant maintenance during the first few years, there are no long-term monitoring, operations, or maintenance requirements.

**Effectiveness.** This alternative is effective because the non-dioxin/furan hot spots and the relatively higher-concentration portion of the dioxin/furan hot spots are removed off-site to a controlled landfill and the remaining impacted soil is removed to a controlled, on-site landfill. Capping of the landfill area is a very effective means to address risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. Long term, there would be some mixing of cap and underlying soils resulting from activity of burrowing mammals. The resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require approximately six months to construct and it would be protective immediately after implementation.

**Long-Term Reliability.** Disposal of the non-dioxin/furan hot spots and the relatively higher-concentration portion of the dioxin/furan hot spots has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring. The long-term reliability of this alternative requires maintenance of the cap, engineering and institutional controls, and enforcement of the SMP. Consolidating the material in one location on-site improves the long-term reliability relative to capping. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk.

**Implementability.** This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 5,500 to 8,500 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. Construction of a large on-site landfill is likely to be less accepted by the community than removal or on-site capping. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. Excavation is generally compatible with any potential source control action, in-water remedy, or habitat restoration. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

**Implementation Risk.** Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 5,500 to 8,500 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – Much of the Facility is covered with native plant communities including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 70,000 to 130,000 truck miles.

**Reasonableness of Cost.** Tables 8a and 8b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents excavation depths of 1 to 3 feet and cap thicknesses of 1 to 2 feet).

| | |
|---|---|
| Capital | $ 4,720,000 to 7,870,000 |
| Long-Term (NPV) | $ 270,000 to 310,000 |
| Contingency | $ 750,000 to 1,230,000 |
| Total (NPV) | $ 5,740,000 to 9,410,000 |

**Treatment or Removal of Hot Spots.** This alternative addresses the non-dioxin/furan hot spots by complete removal to a controlled landfill. This alternative addresses the relatively higher-concentration portion of the dioxin/furan hot spots by complete removal to a controlled landfill.

## 8.6 Alternative 6 – Focused Excavation and Off-Site Disposal with Cap

**Description.** For this alternative, soil in the non-dioxin/furan hot spot areas and soil exceeding the dioxin/furan remediation level would be excavated and disposed of in an off-site landfill. The final depth of excavation would be based on verification sampling, but a depth of 1 to 3 feet is assumed. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal in a Subtitle D landfill; otherwise hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the hot spot levels. The excavations would be backfilled with on-site materials. Remaining on-site baseline risk would be managed with an engineered cap to prevent direct contact by both human and ecological receptors. Figure 20 shows the removal areas and the proposed cap area. Figure 17 presents representative excavation (Detail H) and cap (Detail A) cross-sections. In general, existing vegetation would be cleared to the ground surface and recycled at a composting facility or reused on-site as mulch. Roots and other debris below the ground surface would remain. After the soil removal and site grading, one to two feet of clean, imported fill would be placed and the surface would be finished with native grasses, shrubs, and trees. A temporary irrigation system would be required for at least the first growing season. The cap would cover a total area of approximately 980,000 square feet for a total quantity of 36,000 to 73,000 cubic yards (61,000 to 120,000 tons). The total area of the soil removal would be approximately 150,000 square feet for a total quantity of 5,600 to 17,000 cubic yards (10,000 to 30,000 tons).

Along the riverbank, construction would need to be coordinated with source control, habitat restoration, and/or in-water remedial actions. Figure 18 shows a typical conceptual cross-section of the riverbank construction (Detail F). In general, the riverbank in the removal areas would be excavated to reduce the slope to not greater than 3H:1V. Outside the removal areas, the cap would extend down the riverbank, if needed based on verification sampling of the excavated area or bank. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail may be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, cap inspection/repair, plant inspection and replacement, herbivory control, and invasive species control. A minimum of five years of active inspection and maintenance is expected. Long-term annual inspection would be required thereafter.

Institutional and engineering controls, including an SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the cap and contamination would be required.

Capped areas could be developed for passive or active recreational use as discussed in planning documents. Other uses would also be possible provided that those uses are compatible with the presence of the cap and the associated restrictions.

Protectiveness. This alternative is protective of human and ecological receptors by preventing direct contact with soil containing COCs through a combination of removal of higher relative concentration material and prevention of direct contact through caps and engineering controls. In addition, the higher relative concentration materials would be removed from the site to a controlled landfill. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

Effectiveness. This alternative is effective because the non-dioxin/furan hot spots and the relatively higher-concentration portion of the dioxin/furan hot spots are removed off-site to a controlled landfill and the cap addresses remaining risks associated with direct contact or dust. A soil cap is effective in this case because the COCs have relatively low solubility so are immobile. Long-term, there would be some mixing of cap and underlying soils resulting from activity of burrowing mammals. The resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to construct and it would be protective immediately after implementation.

Long-Term Reliability. Disposal of the non-dioxin/furan hot spots and the relatively higher-concentration portion of the dioxin/furan hot spots has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring. The long-term reliability of this alternative requires maintenance of the cap, engineering and institutional controls, and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk.

Implementability. This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 5,500 to 12,000 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative would remove these trees. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. A portion of the cap could be removed as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

**Implementation Risk.** Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 5,500 to 12,000 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – Much of the Facility is covered with native plant communities including mature stands of madrone and poplar. This alternative would remove these plant communities, and although native species would be replanted, it would be decades before these mature trees would be replaced. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 70,000 to 165,000 truck miles.

**Reasonableness of Cost.** Tables 9a and 9b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents excavation depths of 1 to 3 feet and cap thicknesses of 1 to 2 feet).

| | |
|---|---|
| Capital | $ 3,800,000 to 6,260,000 |
| Long-Term (NPV) | $ 220,000 to 260,000 |
| Contingency | $ 600,000 to 980,000 |
| Total (NPV) | $ 4,620,000 to 7,500,000 |

**Treatment or Removal of Hot Spots.** This alternative addresses the non-dioxin/furan hot spots by complete removal to a controlled landfill. This alternative addresses the relatively higher-concentration portion of the dioxin/furan hot spots by complete removal to a controlled landfill.

## 8.7 Alternative 7 – Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction

**Description.** This alternative would consist of excavation of higher relative concentration soil for off-site disposal, placement of a thin layer soil cap, and restricting site access and use.

Soil in the non-dioxin/furan hot spot areas and soil exceeding the dioxin/furan remediation level would be excavated and disposed of in an off-site landfill. Within the drip line of designated trees, low impact excavation techniques, such as hand or vacuum excavation, would be used to remove soil to the maximum extent practicable without damaging the trees. The presumed excavation depth within the tree drip lines is 1 foot. Outside of these areas, soil would be excavated using standard construction equipment to depths of 1 to 3 feet, as determined by verification sampling. It is assumed that the soil would not be a hazardous waste (would be verified during design/construction). If necessary, stabilization could be used as a supplemental technology to treat hazardous wastes to non-hazardous conditions prior to disposal in a Subtitle D landfill; otherwise hazardous wastes would require disposal at a Subtitle C landfill. Confirmation sampling may be completed to verify removal of the soil above the hot spot levels. The excavations would be backfilled with on-site materials.

Remaining ecological baseline risk would be managed with a 0.5- to 1-foot amended soil cap. The thin-layer cap reduces ecological risk through multiple mechanisms. First, it would immediately prevent direct contact with soil for many species such as birds, shallow rooted plants, and invertebrates. Second, amendments in the soil reduce the bioavailability of the COCs. Finally, over time, activity by burrowing animals would mix the cap material into the surface soil, reducing overall concentrations of the existing surface soil. During the design phase, immobilization additives would be evaluated for use in the thin-layer cap. For example, the addition of activated carbon in the cap material could reduce the bioavailability of HPAHs in the western ecological cleanup area or dioxins/furans throughout much of the Facility. Amending soil with organic matter as a means to reduce toxicity by limiting bioavailability has been identified as an effective technology at contaminated sites (EPA, 2007).

Remaining human health risk would be addressed through engineering and institutional controls including information signs providing background on the reclamation of the site and a deed notice restricting site uses to passive recreation only.

Figure 20 shows the removal areas and the proposed cap area. Figure 17 presents representative excavation (Detail I) and cap (Detail C) cross-sections. In general, existing vegetation would be completely cleared only in the removal areas outside of the drip lines of trees to be saved. In the cap areas, shrubs/grasses would be closely mowed and invasive species would be removed, but trees would remain. Excavation and thin-layer cap placement would be conducted in consultation with an arborist so as to not endanger larger trees. After placement of the thin-layer cap, the surface would be finished with native grasses, shrubs, and trees. A temporary irrigation system would be required for at least the first growing season. The cap would cover a total area of approximately 980,000 square feet for a total quantity of 19,000 to 36,000 cubic yards (32,000 to 61,000 tons). The total area of the soil removal would be approximately 150,000 square feet. Of that total, 30,000 square feet would be within the drip lines of trees to be saved. The total quantity of excavated soil would be 1,100 cy (2,000 tons) within the drip lines of trees and 4,400 to 13,300 cubic yards (8,000 to 24,000 tons) elsewhere.

Along the riverbank, construction would need to be coordinated with source control, habitat restoration, and/or in-water remedial actions. Figure 18 shows a typical conceptual cross-section of the riverbank construction (Detail F). In general, the riverbank in the removal areas would be excavated to reduce the slope to not greater than 3H:1V. Outside the removal areas, the thin-layer cap would extend down the riverbank, if needed based on verification sampling. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail may be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, plant inspection and replacement, herbivory control, and invasive species control. Five years of active inspection and maintenance is expected.

Institutional and engineering controls including a SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the contamination and limitations on site use would be required.

**Protectiveness.** This alternative is protective of human and ecological receptors through a combination of removal of higher relative concentration material, short-term prevention of direct contact through caps and engineering controls, and long-term reduction of toxicity though immobilization and/or mixing of impacted soil with cap materials. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

**Effectiveness.** This alternative is effective because the non-dioxin/furan hot spots and the relatively higher-concentration portion of the dioxin/furan hot spots are removed off-site to a controlled landfill and the thin-layer cap addresses remaining risks associated with direct contact or dust. A thin-layer soil cap is effective in this case because the COCs have relatively low solubility so are immobile. Long term, there would be mixing of cap and underlying soils resulting from activity of burrowing mammals. The resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to construct and it would be protective immediately after implementation.

**Long-Term Reliability.** Disposal of the non-dioxin/furan hot spots and the relatively higher-concentration portion of the dioxin/furan hot spots has good long-term reliability because the landfill is a controlled disposal facility that is required to conduct long-term maintenance and monitoring. The long-term reliability of this alternative requires engineering and institutional controls and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. Because this alternative relies on natural processes to mix the soil and thin-layer cap material, there is not a need for reliance on long-term cap maintenance.

**Implementability.** This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 3,300 to 6,700 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative maintains these trees and much of the natural habitat. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. A small portion of the cap could be removed as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

**Implementation Risk.** Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 3,300 to 6,700 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – This alternative would carry low risk to native plant communities. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the landfill is located within 30 miles and the soil borrow source is located within 10 miles of the site, the project would generate approximately 47,000 to 110,000 truck miles.

**Reasonableness of Cost.** Tables 10a and 10b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents excavation depths of 1 to 3 feet and cap thicknesses of 0.5 to 1 foot).

| | |
|---|---|
| Capital | $ 3,150,000 to 5,220,000 |
| Long-Term (NPV) | $ 90,000 |
| Contingency | $ 480,000 to 790,000 |
| Total (NPV) | $ 3,720,000 to 6,100,000 |

**Treatment or Removal of Hot Spots.** This alternative addresses the non-dioxin/furan hot spots by complete removal to a controlled landfill. This alternative addresses the relatively higher-concentration portion of the dioxin/furan hot spots by complete removal to a controlled landfill.

## 8.8 Alternative 8 – Alternate Cap and Access Restriction

**Description.** This alternative would consist of placement of a thin-layer soil cap and restricting site access and use.

Ecological baseline risk would be managed with a 0.5- to 1-foot amended soil cap over the Site. The thin-layer cap reduces ecological risk through multiple mechanisms. First, it would immediately prevent direct contact with soil for many species such as birds, shallow rooted plants, and invertebrates. Second, amendments in the soil reduce the bioavailability of the COCs. Finally, over time, activity by burrowing animals would mix the cap material into the surface soil, reducing overall concentrations of the existing surface soil. During the design phase, immobilization additives could be evaluated for use in the thin-layer cap. For example, the addition of activated carbon in the cap material could reduce the bioavailability of HPAHs in the western ecological cleanup area or dioxins/furans throughout much of the Facility. Amending soil with organic matter as a means to reduce toxicity by limiting bioavailability has been identified as an effective technology at contaminated sites (EPA, 2007).

Human health risk would be addressed through engineering and institutional controls including information signs providing background on the reclamation of the site and a deed notice restricting site uses to passive recreation only.

Figure 16 shows the proposed cap area, and Figure 17 is a representative cap cross-section (Detail C). Prior to capping, shrubs/grasses would be closely mowed and invasive species would be removed, but trees would remain. The thin-layer cap would be placed in consultation with an arborist so as to not endanger larger trees. After placement of the thin-layer cap, the surface would be finished with native grasses, shrubs, and trees. A temporary irrigation system would be required for at least the first growing season. The cap would cover a total area of approximately 980,000 square feet for a total quantity of 18,000 to 36,000 cubic yards (31,000 to 62,000 tons).

Along the riverbank, construction would need to be coordinated with source control actions and/or in-water remedial actions. Figure 18 shows a typical conceptual cross-section of the riverbank construction (Detail G). In general, the thin-layer cap would extend down the riverbank as needed. Work within 50 feet of the top of bank would be conducted as part of the source control, in-water remediation, and/or habitat restoration. This bank detail would be revised if further mitigation work is completed along the riverbank.

Dust control and use of personal protective equipment for construction workers are included in this alternative.

Operation and maintenance would include irrigation, plant inspection and replacement, herbivory control, and invasive species control. Five years of active inspection and maintenance is expected.

Institutional and engineering controls including a SMP, signage, and designated pathways would be used indefinitely. A deed restriction identifying the presence of the contamination and limitations on site use would be required.

**Protectiveness.** This alternative is protective of human and ecological receptors through a combination of short-term prevention of direct contact through caps and engineering controls, and long-term reduction of toxicity though immobilization and/or mixing of impacted soil with cap materials. Signs, deed restrictions, and the SMP would assure this protectiveness in the long term.

**Effectiveness.** A thin-layer soil cap is effective in this case because the COCs have relatively low solubility so are immobile. None of the COC mass would be removed from the site. Long term, there would be mixing of cap and underlying soils resulting from activity of burrowing mammals. Except potentially in the hot spot areas, the resulting mixing of the soils is not expected to result in surface soil concentrations that exceed PRGs. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. The alternative is estimated to require less than six months to construct and it would be protective immediately after implementation.

**Long-Term Reliability.** The long-term reliability of this alternative requires engineering and institutional controls and enforcement of the SMP. Because this is a publicly owned property, the engineering and institutional controls are expected to adequately manage long-term risk. Because this alternative relies on natural processes to mix the soil and thin-layer cap material, there is not a need for reliance on long-term cap maintenance.

**Implementability.** This alternative uses standard construction services that are readily available. Access to the site is through residential neighborhoods and the project would require on the order of 2,400 to 4,800 truck trips through the neighborhood assuming 15 cy per truck and two trips per load. The site has several stands of mature native species that are targets for restoration under local government plans. This alternative maintains these trees and much of the natural habitat. An upland cap is generally compatible with any potential source control action, in-water remedy, or habitat restoration. A small portion of the cap could be removed as part of actions that reduce the overall slope of the bank. Remediation of areas along the riverbank would be implemented together with in-water remedies, habitat restoration, or source control actions.

**Implementation Risk.** Implementation risks include potential impacts to the community, site workers, and the environment during implementation, summarized as follows.

- Community – An estimated 2,400 to 4,800 truck trips would be required through the adjacent residential communities. This brings noise and air pollution to this neighborhood. Motor vehicle accidents, including the potential for vehicle/pedestrian or vehicle/bicycle accidents, are a possibility.
- Site Workers – Risks to construction workers include physical hazards from heavy construction equipment and inhalation of dust. These risks are readily addressed with engineering controls (e.g., high visibility gear, dust suppression) and personal protective gear.
- Environment – This alternative would carry low risk to native plant communities. Equipment and trucks used for the work would be diesel powered, contributing greenhouse gases to the atmosphere. Assuming the soil borrow source is located within 10 miles of the site, the project would generate approximately 24,000 to 48,000 truck miles.

**Reasonableness of Cost.** Tables 11a and 11b provide detailed cost estimates for this alternative. Costs include direct/indirect capital costs (e.g., design, permitting, construction), annual operation/maintenance costs, and costs of periodic reviews. Costs are stated in terms of NPV assuming that capital costs are incurred in year zero. Costs for this alternative are summarized as follows (the range represents excavation cap thicknesses of 0.5 to 1 foot).

| | |
|---|---|
| Capital | $ 2,190,000 to 3,440,000 |
| Long-Term (NPV) | $ 60,000 |
| Contingency | $ 340,000 to 520,000 |
| Total (NPV) | $ 2,590,000 to 4,020,000 |

**Treatment or Removal of Hot Spots.** This alternative does not treat or remove hot spots.

# 9.0 Comparative Evaluation of Remedial Action Alternatives

This section of the FS presents an evaluation of the remedial action alternatives relative to one another. The comparative analysis is summarized in Table 12. In the table, each alternative is compared to each of the other alternatives for each evaluation criterion. An alternative is ranked as favorable (+), equal (0), or unfavorable (-) in relation to every other alternative, with a corresponding score of 1, 0, or -1. The scores are summed at the right of the table for each alternative and the alternatives are ranked. The following discussion provides the rationale for the comparative evaluation presented in Table 12.

## 9.1 Protectiveness

This criterion is pass/fail. An alternative must be protective as defined by OAR 340-122-040 to be acceptable. With the exception of the No Action alternative, each of the remedial action alternatives is protective of human health and the environment. The alternatives were not scored based on this criterion, but protectiveness was considered when ranking the alternatives in the right-hand column.

## 9.2 Effectiveness

Except for Alternatives 1 and 8, each of the alternatives provides good to excellent effectiveness. Alternative 1 is not effective. For Alternative 8, because the higher concentration material is not removed, there is some uncertainty in the effectives of the thin-layer cap in those areas. In general, off-site disposal was ranked more effective than capping or on-site disposal because of better control of the impacted soil. For capping alternatives, smaller cap areas and thicker caps were deemed to be more effective. Alternatives 4 and 6 were considered to be equally effective because Alternative 4 consolidates material into a smaller cap area, but Alternative 6 removes the higher concentration material to an off-site landfill. Therefore, the alternatives were ranked from most to least effective as follows:

- Alternatives 3a and 3b;
- Alternative 5;
- Alternatives 4 and 6;
- Alternative 7;
- Alternative 2;
- Alternative 8;
- Alternative 1.

## 9.3 Long-Term Reliability

For long-term reliability, off-site controlled landfill disposal was deemed to be more reliable. For capping alternatives, alternatives that included removal were assumed more reliable, and for capping alternatives that did not include removal, smaller cap areas were assumed more reliable. Other things being equal, alternatives that required less long-term maintenance were assumed to be more reliable. Alternatives 4, 6, and 7 were considered to be equally reliable because Alternative 4 consolidates material into a smaller cap area, but Alternatives 6 and 7 remove the higher concentration material to an off-site landfill. Therefore, the alternatives were ranked from highest to lowest for long-term reliability as follows:

- Alternatives 3a and 3b;
- Alternative 5;

- Alternatives 4, 6, and 7;
- Alternatives 2 and 8;
- Alternative 1.

## 9.4 Implementability

Alternative 1 was considered the most easily implemented remedial action. The remaining alternatives use similar equipment and techniques, are similarly compatible with other actions, but have differing impacts on the neighborhood and plant communities. The ability to implement these alternatives is assumed to be directly related to acceptance by the local community and local planning agencies. Alternatives with fewer truck trips and less impact to native vegetation were assumed to be more implementable. Construction of a large on-site landfill is not expected to be acceptable to the community or planning agencies. Based on these criteria, the alternatives were ranked from most to least implementable as follows:

- Alternative 1;
- Alternative 8;
- Alternative 7;
- Alternative 2;
- Alternatives 3b and 6;
- Alternative 3a;
- Alternative 4;
- Alternative 5.

## 9.5 Implementation Risk

Alternative 1 carries no implementation risk. Alternatives with greater quantities of earthwork carry greater risk from dust, vehicle accidents, noise/pollution, destruction of habitat, and generation of greenhouse gases and therefore rank lower. Alternatives were generally ranked based on truck trips/truck miles (higher-ranked alternatives having fewer trips/miles), quantities of earthwork (lower quantities rank higher), and impacts to Site habitat (less destruction ranked higher). Alternatives were ranked from least to most implementation risk as follows:

- Alternative 1;
- Alternative 8;
- Alternative 7;
- Alternative 2;

- Alternative 4;
- Alternative 6;
- Alternative 5;
- Alternative 3b;
- Alternative 3a.

## 9.6 Reasonableness of Cost

The following summarizes the present-worth total cost estimates for each alternative listed from least to most costly.

- Alternative 1 – No Action: $ 0;
- Alternative 8 – $ 2.6-4.0 million;
- Alternative 2 – $ 3.7-5.3 million
- Alternative 7 – $ 3.7-6.1 million;
- Alternative 6 – $ 4.6-7.5 million;
- Alternative 4 – $ 5.1-7.6 million;
- Alternative 5 – $ 5.7-9.4 million;
- Alternative 3b – $ 8.3-15 million;
- Alternative 3a – $ 8.5-17 million.

## 9.7 Treatment or Removal of Hot Spots

The general practicability of removal of hot spots was evaluated in Section 6.1 and Appendix D. Based on that evaluation, it is practicable to remove approximately 90 percent of the hot spot (on a chemical mass basis). This conclusion is supported by the comparison of active alternatives, summarized as follows.

- No hot spot treatment or removal – Alternative cost range: $2.6 million to $7.6 million.
- Remove approximately 90 percent of hot spots – Alternative cost range: $3.7 million to $9.4 million.
- Remove entire hot spot – Alternative cost: $8.5 million to $17 million.

To remove the first 90 percent of the hot spots increases the average cost of the alternatives by $1.4 million or approximately 30 percent of the total cost. To remove the last 10 percent of the hot spot requires an additional $5 million to $8 million (or approximately 100 percent cost increase). Based on this analysis and the discussion in Appendix D, it is feasible and practicable to remove the majority of the hot spots (on a chemical mass basis), but removal of the entire hot spot area is not practicable.

# *10.0 Recommendation*

## 10.1 Recommended Remedial Action Alternative: Alternative 7 – Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction

Based on the evaluation of remedial action alternatives in Section 9, the recommended remedial action alternative for the Facility is Alternative 7 – Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction. This alternative is recommended for the following reasons.

- The alternative is protective of human health and the environment through a combination of removal of higher relative concentration material, short-term prevention of direct contact through caps and engineering controls, and long-term reduction of toxicity through immobilization and/or mixing of impacted soil with cap materials.
- The alternative overall ranks the highest when considering the balancing factors with equal weighting.
- The alternative removes hot spots to a controlled landfill to the extent practicable.

## 10.2 Permit or Permit Exemption Requirements

The recommended alternative consists primarily of excavation and filling of greater than 20,000 cubic yards of soil. The work will include excavation and/or filling both above and below the line of ordinary high water. A grading permit (or permit exemption) from the City of Portland will be required to complete the upland work, including requirements associated with Greenway review. An in-water work permit (addressing federal and state requirements for filling, water quality, etc.) will be required from the U.S. Army Corps of Engineers for the work below the line of ordinary high water. A construction stormwater permit will be needed to address runoff of stormwater during implementation of the remedy. No other permits are anticipated to be required.

## 10.3 Residual Risk Assessment

### *10.3.1 Residual Risk Methodology*

The residual risks were evaluated to assess the projected level of health and/or ecological risk that is anticipated if the recommended alternative is implemented. Assessment of residual risk is intended to assist risk managers in determining whether a remedial action plan will result in acceptable risk.

The residual risk evaluation was conducted using the same methods used in the baseline RHHRA and RERA and the subsequent risk memorandum (Formation; 2013, 2014a, and 2014b). Exposure point concentrations (EPCs) were calculated to reflect the effect of the recommended alternative on exposure and risk. Residual risk was evaluated for the West Parcel Exposure Unit (EU), the Central Parcel EU, and the East Parcel EU.[2] In general, where there was sufficient data, EPCs for the residual risk analysis were calculated using the 90 percent upper confidence limit of the mean (90UCL) after modifying sample results to reflect changes resulting from the recommended remedial action. Otherwise, the maximum remaining value was used. The following summarizes the steps used to establish the data sets used to calculate EPCs.

- General steps
  - Identify analytes of interest in the FS dataset.
  - Exclude certain locations/data from this analysis based on depth below exposure area or location outside exposure area.
  - Identify locations that would be removed to an off-site landfill by remediation activities. For those locations, replace existing COC results with a proxy value representing the expected concentration post-remediation.
  - For each analyte, review available results and identify if there are locations with multiple values (multiple depths or co-located samples) that needed to be evaluated/streamlined prior to 90UCL calculations.
- Analytes of interest: Only COCs identified in the RHHRA or RERA (as listed in Tables 1 or 2) were evaluated.
- Results excluded from the post-remediation residual risk analysis:
  - Samples collected from greater than 3 feet in depth (8 locations); and
  - Trench samples located on the beach outside the upland facility (3 locations).
- Identify locations removed by remediation activities: Table E-1 in Appendix E shows the samples that are located in the areas targeted for removal in the recommended remedial action.
  - For ISM samples DU-1 through DU-3 and DU-6, nearly half or more of the area would be removed. These samples were removed from the residual risk database.
  - For ISM samples DU-4 and DU-5, a portion of the higher concentration soil, representing 2 to 9 of the 50 subsamples, would be removed. These samples were kept in the database, but are further evaluated based on the portions to be removed.
  - At locations with multiple samples at different depths where only the upper sample is targeted for removal, the concentration in the lower sample was used as the proxy concentration.

[2] Although the Inner Cove Beach EU and Central Beach EU were included in the RRA, they are not part of the Upland Facility and therefore not considered in the FS.

- At other locations, the proxy concentration was calculated from site-specific data as the mean of all samples from the FS database with a concentration less than the median value. The proxy concentrations thus calculated are listed below (all values in mg/kg).

| | |
|---|---|
| Antimony – 0.46 | Total PCBs – <0.046 |
| Arsenic – 3.2 | HPAHs – 0.88 |
| Cadmium – 0.19 | BaP Equivalent – 0.15 |
| Chromium – 15 | BaP – 0.10 |
| Copper – 34 | Benzo(a)anthracene – 0.067 |
| Lead – 43 | Benzo(b)fluoranthene – 0.11 |
| Mercury – 0.21 | Benzo(k)fluoranthene – 0.085 |
| Nickel – 20 | Dibenz(a,h)anthracene – 0.026 |
| Zinc – 140 | |

- Adjustments at locations with multiple values:
  - Locations with two values at different depths: averaged concentrations using the following decision rules (average if both detected; if one detected and one not detected, use the detected value; if both not detected, use max detection limit).
  - Replacement values at locations with multiple samples (e.g., from different sampling events or different depths): used a single replacement value (not two) for that location.

Using this procedure, post-remediation EPCs were calculated and are presented in Tables E-2 through E-5 in Appendix E for ecological COCs and in Table E-6 for human health COCs.

This analysis does not quantify the reduction in exposure resulting from the deed restrictions or thin-layer cap. Rather, the results identify the residual risks after focused excavation and off-site disposal only. These residual risks will be addressed through deed/land-use restrictions and the thin-layer cap.

### *10.3.2 Results for Ecological Risk*

In Tables E-2 through E-5, EPCs are compared to ecological PRGs for each receptor type and exposure area. EPCs that exceed the ecological PRGs are highlighted and the exceedance factors are shown. The risks shown in the tables represented by the exceedance factors are the risks remaining after the proposed removals that would be addressed by the thin-layer cap. The following paragraphs summarize the results of the ecological residual risk calculations for each exposure area.

West Parcel. Copper, mercury, and dioxins/furans would be present above ecological PRGs for plants, invertebrates, and/or mammals. The exceedance factors for metals are less than 2. The exceedance factor for dioxins/furans is 5 (mammals).

Central Parcel. Metals, PAHs, and dioxins/furans would be present above ecological PRGs, summarized as follows.

- Plants – Copper, lead, mercury, and zinc would be present above PRGs. Exceedance factors for copper and lead range up to 3.3 and 4.2. The maximum exceedance factor for zinc is 6.7, but this represents a relatively small area based on the ISM exceedance factor of only 1.3. For mercury, the exceedance factor is 9 for discrete samples and 23 for the ISM sample. However, the ISM sample (DU-5), is biased high for the residual risk because it does not account for the removal areas. Nine of the 50 subsamples for the ISM sample were located in areas that would be removed.
- Invertebrates – Copper, zinc, and HPAHs would be present above PRGs. Exceedance factors for HPAHs and copper range up to 1.7 and 3.7. The maximum exceedance factor for zinc is 6.7, but this represents a relatively small area based on the ISM exceedance factor of only 1.3.
- Birds – Copper, lead, and dioxins/furans would be present above PRGs. Exceedance factors range up to 3.9 for metals and 1.1 for dioxins/furans.
- Mammals – Copper, lead, zinc, HPAHs, and dioxins/furans would be present above PRGs. Exceedance factors for metals and HPAHs range up to 3.6 and 1.3. The maximum exceedance factor for dioxins/furans is 7.8.

East Parcel. Antimony, copper, lead, mercury, nickel, zinc, and dioxins/furans would be present above ecological PRGs for plants, invertebrates, birds, and/or mammals. The exceedance factors for metals range up to 3.7 (mercury at one sample location). The exceedance factor for dioxins/furans is 3 (mammals).

### *10.3.3 Results for Human Health*

In Table E-6, EPCs are compared to human health PRGs for each exposure area. The residual risk analysis was conducted for the three receptor types described in the RRA: transient trespasser, construction worker, and recreational trespasser/park user (see Section 3.2). EPCs that exceed the human health PRGs are highlighted and the exceedance factors are shown. The risks shown in the tables represented by the exceedance factors are the risks remaining after the proposed removals that would be addressed by the access restrictions, institutional controls, and thin-layer cap. The following paragraphs summarize the results of the human health residual risk calculations for each exposure area.

West Parcel. Residual risks for the transient trespasser and construction worker are acceptable. Unacceptable risks for the recreational trespasser/park user were identified for PAHs and dioxins/furans. Exceedance factors ranged up to 9 for individual PAHs (representing an excess lifetime cancer risk of $9 \times 10^{-6}$), 13 for total PAHs, and 9 for dioxins/furans (TEQ concentration), representing a cumulative excess lifetime cancer risk of $2 \times 10^{-5}$.

Central Parcel. Residual risks for the transient trespasser and construction worker are acceptable. For the transient trespasser, exceedance factors are less than one. For the construction worker, exceedance factors range up to 1.3, corresponding to a risk level of $1 \times 10^{-6}$, and therefore, meeting the acceptable risk level. Unacceptable risks for the recreational trespasser/park user were identified for PAHs and dioxins/furans. Exceedance factors ranged up to 17 for individual PAHs (representing an excess lifetime cancer risk of 2 x $10^{-5}$), 23 for total PAHs, and 14 for dioxins/furans (TEQ concentration), representing a cumulative excess lifetime cancer risk of 4 x $10^{-5}$.

**East Parcel.** Residual risks for the transient trespasser and construction worker are acceptable. Unacceptable risks for the recreational trespasser/park user were identified for PAHs and dioxins/furans. Exceedance factors ranged up to 4 for individual PAHs (representing an excess lifetime cancer risk of 4 x $10^{-6}$), 6 for total PAHs, and 5 for dioxins/furans (TEQ concentration), representing a cumulative excess lifetime cancer risk of 1 x $10^{-5}$ (meeting the cumulative acceptable risk level).

#### *10.3.4 Residual Risk Conclusions*

Risks remaining following completion of the removal portion of the recommended alternative are summarized as follows.

- West Parcel
    - Human Health – Risks meet the acceptable risk levels except that for the recreational trespasser/park user, acceptable risk levels are exceeded by factors of up to 13 for PAHs and 9 for dioxins/furans.
    - Ecological – Metals exceed acceptable risk levels by factors of up to 1.5. Dioxins/furans exceed acceptable risk levels by factors of up to 5.
- Central Parcel
    - Human Health – Risks meet the acceptable risk levels except that for the recreational trespasser/park user, acceptable risk levels are exceeded by factors of up to 23 for PAHs, and 14 for dioxins/furans.
    - Ecological – Metals, HPAHs, and dioxins/furans would exceed the acceptable risk levels, summarized as follows.
        - Copper and lead have exceedance factors in the range of 2 to 4.
        - Zinc generally has exceedance factors of less than 3 except one sample exceeds the PRG for plants and invertebrates by a factor of nearly 7.
        - Mercury exceeds the PRG for plants and invertebrates by a factor of 9 (the ISM sample DU-5 exceeds the PRG by a factor of 23, but is biased high for the residual risk because it does not account for the removal of nine of the 50 ISM subsamples).
        - HPAHs exceed invertebrate and mammal PRGs by factors of less than 2.

    - Dioxins/furans exceed PRGs for birds and mammals by factors of 1.1 and 7.8, respectively.

- East Parcel
  - Human Health – Risks meet the acceptable risk levels except that for the recreational trespasser/park user, acceptable risk levels are exceeded by factors of up to 6 for PAHs and 5 for dioxins/furans.
  - Ecological – Metals exceed acceptable risk levels by factors of up to 3.7. Dioxins/furans exceed acceptable risk levels by factors of up to 3.

The removal portion of the recommended alternative would substantially reduce exposure and risks for both human and ecological receptors. For human health, the residual risks following removal would be managed through deed/land-use restrictions and the thin-layer cap. For ecological receptors, residual risk estimates exceed acceptable risk levels by factors ranging from 1.1 to 9 for metals and from 1.1 to 7.8 for organics. The reduction in exposure from the cap, the reduction in bioavailability of organic COCs, and the conservatism built into the exposure estimates result in qualitative risk estimates that are equivalent to acceptable risk levels for non-threatened/endangered species. The thin-layer cap was proposed, in part, to avoid damage to existing ecological features at the site, particularly the mature native trees. More aggressive remediation approaches, such as a thicker, more highly engineered cap or more extensive excavation, could damage the trees, resulting in adverse ecological effects that are not likely to result from the thin-layer cap. This approach is consistent with DEQ feasibility study rules and guidance that consider the balance between such factors as the effectiveness of an alternative and associated implementation risk.

# 11.0 References

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**Table 1. Preliminary Remediation Goals and Oregon High-Concentration Hot Spots Values, Willamette Cove Feasibility Study.**

| | | *Plants (mg/kg)* | | | *Invertebrates (mg/kg)* | | *Birds (mg/kg)* | | *Mammals (mg/kg)* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical of Concern** | **Units** | **Plant Screening Levels[1]** | ***Alternative Plant PRGs based on Soil pH[2]*** | ***Plant Hot Spot*** | **Invertebrate Screning Levels[1]** | **Invertebrate Hot Spot** | **Birds RBC[3,8,9]** | **Bird Hot Spot** | **Mammals RBC[3,9]** | **Mammal Hot Spot** | **Background[4]** | **Lowest RBC** | **PRG** | **Eco Risk Hot Spot[7]** |
| Antimony | mg/Kg dw | 5[a] | | 50 | *not a COC* | | *not a COC* | | 2.7 | 27 | 0.56 | 2.7 | 2.7 | 27 |
| Cadmium | mg/Kg dw | | | | | | *5.1* | *50* | 6.5 | 65 | 0.63 | 5.1 | 5.1 | 51 |
| Chromium | mg/Kg dw | 1[b] | | 10 | 0.4[d] | 4 | *not a COC* | | *not a COC* | | 76 | 0.4 | 76 | none |
| Copper | mg/Kg dw | 70[c] | 115-251 for pH >6; Geomean = 160[c] | 700 (1,600) | 80[c] | 800 | 87.7 | 877 | 82 | 820 | 34 | 70 | 70 | 700 |
| Lead | mg/Kg dw | 120[c] | 141-316 for pH>6. Geomean = 211[c] | 1,200 (2,110) | *not a COC* | | 43 | 430 | 122 | 1220 | 79 | 43 | 79 | 430 |
| Mercury | mg/Kg dw | 0.3[b] | | 3 | *not a COC* | | *not a COC* | | *not a COC* | | 0.23 | 0.3 | 0.3 | 3 |
| Nickel | mg/Kg dw | 38[c] | 32-177 for pH>6. Geomean = 62[c] | 380 (620) | *not a COC* | | *not a COC* | | *not a COC* | | 47 | 38 | 47 | 380 |
| Zinc | mg/Kg dw | 160[c] | 173-185 for pH>6. Geomean = 178[c] | 1,600 (1,780) | 120[c] | 1,200 | 673 | 6,730 | 201 | 2010 | 180 | 120 | 180 | 1200 |
| HPAH[5] | mg/Kg dw | *not a COC* | | | 18[c] | 180 | *not a COC* | | 5.6 | 56 | na | 5.6 | 5.6 | 56 |
| Dibenzofuran | mg/Kg dw | *not a COC* | | | *not a COC* | | *not a COC* | | 1.00E-02 | 1.00E-01 | na | 0.01 | 0.01 | 0.1 |
| Diesel[6] | mg/Kg dw | *See note 5* | | | | | | | | | na | -- | -- | -- |
| PCBs | mg/Kg dw | 40[b] | | 400 | *not a COC* | | 0.734 | 7.34 | 0.098 | 0.98 | na | 1.00E-01 | 1.00E-01 | 1 |
| Phthalates[6] | mg/Kg dw | *See note 5* | | | | | | | | | na | -- | -- | -- |
| **Dixons/Furans** | | | | | | | | | | | | | | |
| 2,3,7,8-TCDF | mg/Kg dw | NA | | | NA | | 1.29E-04 | 1.29E-03 | 1.30E-04 | 1.30E-03 | na | 1.30E-04 | 1.30E-04 | 1.30E-03 |
| 2,3,7,8-TCDD | mg/Kg dw | NA | | | NA | | 1.36E-04 | 1.36E-03 | 1.95E-05 | 1.95E-04 | na | 1.95E-05 | 1.95E-05 | 1.95E-04 |
| 1,2,3,7,8-PeCDF | mg/Kg dw | NA | | | NA | | 1.27E-03 | 1.27E-02 | 4.31E-04 | 4.31E-03 | na | 4.31E-04 | 4.31E-04 | 4.31E-03 |
| 2,3,4,7,8-PeCDF | mg/Kg dw | NA | | | NA | | 3.30E-04 | 3.30E-03 | 3.35E-05 | 3.35E-04 | na | 3.35E-05 | 3.35E-05 | 3.35E-04 |
| 1,2,3,7,8-PeCDD | mg/Kg dw | NA | | | NA | | 5.47E-04 | 5.47E-03 | 5.67E-05 | 5.67E-04 | na | 5.67E-05 | 5.67E-05 | 5.67E-04 |
| 1,2,3,4,7,8-HxCDF | mg/Kg dw | NA | | | NA | | 2.28E-04 | 2.28E-03 | 2.29E-05 | 2.29E-04 | na | 2.29E-05 | 2.29E-05 | 2.29E-04 |
| 1,2,3,6,7,8-HxCDF | mg/Kg dw | NA | | | NA | | 2.28E-04 | 2.28E-03 | 2.29E-05 | 2.29E-04 | na | 2.29E-05 | 2.29E-05 | 2.29E-04 |
| 2,3,4,6,7,8-HxCDF | mg/Kg dw | NA | | | NA | | 2.28E-04 | 2.28E-03 | 2.29E-05 | 2.29E-04 | na | 2.29E-05 | 2.29E-05 | 2.29E-04 |
| 1,2,3,7,8,9-HxCDF | mg/Kg dw | | | | | | 4.48E-04 | 4.48E-03 | 4.52E-05 | 4.52E-04 | na | 4.52E-05 | 4.52E-05 | 4.52E-04 |
| 1,2,3,4,7,8-HxCDD | mg/Kg dw | NA | | | NA | | 1.05E-03 | 1.05E-02 | 5.30E-05 | 5.30E-04 | na | 5.30E-05 | 5.30E-05 | 5.30E-04 |
| 1,2,3,6,7,8-HxCDD | mg/Kg dw | NA | | | NA | | 2.28E-03 | 2.28E-02 | 2.30E-05 | 2.30E-04 | na | 2.30E-05 | 2.30E-05 | 2.30E-04 |
| 1,2,3,7,8,9-HxCDD | mg/Kg dw | NA | | | NA | | 2.28E-04 | 2.28E-03 | 2.30E-05 | 2.30E-04 | na | 2.30E-05 | 2.30E-05 | 2.30E-04 |
| 1,2,3,4,6,7,8-HpCDF | mg/Kg dw | NA | | | NA | | 3.79E-03 | 3.79E-02 | 3.83E-04 | 3.83E-03 | na | 3.83E-04 | 3.83E-04 | 3.83E-03 |
| 1,2,3,4,7,8,9-HpCDF | mg/Kg dw | NA | | | NA | | 3.79E-03 | 3.79E-02 | 3.83E-04 | 3.83E-03 | na | 3.83E-04 | 3.83E-04 | 3.83E-03 |
| 1,2,3,4,6,7,8-HpCDD | mg/Kg dw | NA | | | NA | | 3.87E-02 | 3.87E-01 | 3.91E-04 | 3.91E-03 | na | 3.91E-04 | 3.91E-04 | 3.91E-03 |
| OCDF | mg/Kg dw | NA | | | NA | | 1.64E-01 | 1.64E+00 | 5.49E-03 | 5.49E-02 | na | 5.49E-03 | 5.49E-03 | 5.49E-02 |
| OCDD | mg/Kg dw | NA | | | NA | | 6.43E-01 | 6.43E+00 | 2.17E-02 | 2.17E-01 | na | 2.17E-02 | 2.17E-02 | 2.17E-01 |
| 2,3,7,8-TCDD TEQ | mg/Kg dw | NA | | | NA | | 1.36E-04 | 1.36E-03 | 1.95E-05 | 1.95E-04 | na | 1.95E-05 | 1.95E-05 | 1.95E-04 |

**Notes:**

NA = not available; na = not applicable.

[1]Screening levels cited by sources for screening only, not meant as action levels for risk manageme

[2]Soil toxicity values for plants based on test in which soil pH was =/> 6

[3]Calculated from site-specific exposure scenarios for the American robin and short-tailed shrew; based on LOAEL

[4]Upper Prediction Limit values for Portland Basin from Table 4 in Oregon DEQ. 2013. "Development of Oregon Background Metals Concentrations in Soil". March 2013. Not applicaable for organic comounds

[5]HPAHs = High molecular weight polynuclear aromatic hydrocarbons.The hot spot concentration for HPAHs was based on the EcoSSL, which listed only the value for combined HPAHs. As a result, the total HPAH hot spot value is not consistent with the Oregon rules that specify hot spot concentrations apply only to individual chemicals (DEQ 1998, 2001).

[6]Diesel and Phthalates were identified in Table 4 of DEQ comments on the Eco RRA (July 19, 2013), but the basis for inclusion as COCs was not explained, and quantitative basis for analysis is not possible. Therefore, no PRGs were calculated.

Toxicity Level Sources:
- a - ORNL Ecological PRGs
- b - ORNL-Plant Screening Level
- c - EPA EcoSSLs
- d - Oregon DEQ Level II SLV (screening level)

[7] Lowest Ecological Hot Spot that is greater than Background.

[8]Based on bioavailability of lead from soils is 50%, and 75% from diet.

[9]Dioxin/Furan RBCs and hot spots based on Toxicity Equivalence Factors for birds or mammals (Van den Berg et al. 1998 (birds), Van den Berg et al. 2005 (mammals). Projected uptake of D/Fs from soil into dietary components for ominvore diets (invertebrates, plants) estimated assuming soil organic carbon content of 3%, and using equation from Jager 1998, as cited in EPA 2007.

**Table 2. Preliminary Remediation Goals for Human Receptors, Willamette Cove Upland Facility[1]**

| Chemical Of Concern | Receptor Scenario | Units | RBC Cancer | RBC Non-Cancer | Back-ground[2] | PRG | FS Hot Spot[3] |
|---|---|---|---|---|---|---|---|
| Antimony | Construction Worker | mg/Kg dw | -- | 30.95 | 0.56 | 30.95 | 309.55 |
| Antimony | Recreational Trespasser/Park User | mg/Kg dw | -- | 24.3 | 0.56 | 24.3 | 243 |
| Arsenic | Recreational Trespasser/Park User | mg/Kg dw | 1.31 | 65.6 | 8.8 | 8.8 | 131 |
| Lead | Construction Worker | mg/Kg dw | -- | 614 | 79 | 614 | 6140 |
| Lead | Recreational Trespasser/Park User | mg/Kg dw | -- | 904 | 79 | 904 | 9040 |
| Lead | Transient Trespasser | mg/Kg dw | -- | 1169.5 | 79 | 1169.5 | 11695 |
| Aroclors | Construction Worker | mg/Kg dw | 7.63 | 4.36 | na | 4.36 | 43.6 |
| Aroclors | Recreational Trespasser/Park User | mg/Kg dw | 0.75 | 3.38 | na | 0.75 | 33.8 |
| Aroclors | Transient Trespasser | mg/Kg dw | 13.79 | 15.76 | na | 13.79 | 157.6 |
| Dioxin/furan TEQ | Transient Trespasser | mg/Kg dw | 2.00E-04 | na | na | 2.00E-04 | 2.00E-02 |
| 2,3,7,8-TCDF | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 2,3,7,8-TCDD | Transient Trespasser | mg/Kg dw | 2.08E-04 | na | na | 2.08E-04 | 2.08E-02 |
| 1,2,3,7,8-PeCDF | Transient Trespasser | mg/Kg dw | 6.93E-03 | na | na | 6.93E-03 | 6.93E-01 |
| 2,3,4,7,8-PeCDF | Transient Trespasser | mg/Kg dw | 6.93E-04 | na | na | 6.93E-04 | 6.93E-02 |
| 1,2,3,7,8-PeCDD | Transient Trespasser | mg/Kg dw | 2.08E-04 | na | na | 2.08E-04 | 2.08E-02 |
| 1,2,3,4,7,8-HxCDF | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 1,2,3,6,7,8-HxCDF | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 2,3,4,6,7,8-HxCDF | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 1,2,3,7,8,9-HxCDF | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 1,2,3,4,7,8-HxCDD | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 1,2,3,6,7,8-HxCDD | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 1,2,3,7,8,9-HxCDD | Transient Trespasser | mg/Kg dw | 2.08E-03 | na | na | 2.08E-03 | 2.08E-01 |
| 1,2,3,4,6,7,8-HpCDF | Transient Trespasser | mg/Kg dw | 2.08E-02 | na | na | 2.08E-02 | 2.08E+00 |
| 1,2,3,4,7,8,9-HpCDF | Transient Trespasser | mg/Kg dw | 2.08E-02 | na | na | 2.08E-02 | 2.08E+00 |
| 1,2,3,4,6,7,8-HpCDD | Transient Trespasser | mg/Kg dw | 2.08E-02 | na | na | 2.08E-02 | 2.08E+00 |
| OCDF | Transient Trespasser | mg/Kg dw | 6.93E-01 | na | na | 6.93E-01 | 6.93E+01 |
| OCDD | Transient Trespasser | mg/Kg dw | 6.93E-01 | na | na | 6.93E-01 | 6.93E+01 |
| Dioxin/furan TEQ | Construction Worker | mg/Kg dw | 1.15E-04 | na | na | 1.15E-04 | 1.15E-02 |
| 2,3,7,8-TCDF | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 2,3,7,8-TCDD | Construction Worker | mg/Kg dw | 1.15E-04 | na | na | 1.15E-04 | 1.15E-02 |
| 1,2,3,7,8-PeCDF | Construction Worker | mg/Kg dw | 3.85E-03 | na | na | 3.85E-03 | 3.85E-01 |
| 2,3,4,7,8-PeCDF | Construction Worker | mg/Kg dw | 3.85E-04 | na | na | 3.85E-04 | 3.85E-02 |
| 1,2,3,7,8-PeCDD | Construction Worker | mg/Kg dw | 1.15E-04 | na | na | 1.15E-04 | 1.15E-02 |
| 1,2,3,4,7,8-HxCDF | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 1,2,3,6,7,8-HxCDF | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 2,3,4,6,7,8-HxCDF | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 1,2,3,7,8,9-HxCDF | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 1,2,3,4,7,8-HxCDD | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 1,2,3,6,7,8-HxCDD | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 1,2,3,7,8,9-HxCDD | Construction Worker | mg/Kg dw | 1.15E-03 | na | na | 1.15E-03 | 1.15E-01 |
| 1,2,3,4,6,7,8-HpCDF | Construction Worker | mg/Kg dw | 1.15E-02 | na | na | 1.15E-02 | 1.15E+00 |
| 1,2,3,4,7,8,9-HpCDF | Construction Worker | mg/Kg dw | 1.15E-02 | na | na | 1.15E-02 | 1.15E+00 |
| 1,2,3,4,6,7,8-HpCDD | Construction Worker | mg/Kg dw | 1.15E-02 | na | na | 1.15E-02 | 1.15E+00 |
| OCDF | Construction Worker | mg/Kg dw | 3.85E-01 | na | na | 3.85E-01 | 3.85E+01 |
| OCDD | Construction Worker | mg/Kg dw | 3.85E-01 | na | na | 3.85E-01 | 3.85E+01 |
| Dioxin/furan TEQ | Recreational Trespasser/Park User | mg/Kg dw | 1.12E-05 | na | na | 1.12E-05 | 1.12E-03 |
| 2,3,7,8-TCDF | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 2,3,7,8-TCDD | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-05 | na | na | 1.13E-05 | 1.13E-03 |
| 1,2,3,7,8-PeCDF | Recreational Trespasser/Park User | mg/Kg dw | 3.75E-04 | na | na | 3.75E-04 | 3.75E-02 |
| 2,3,4,7,8-PeCDF | Recreational Trespasser/Park User | mg/Kg dw | 3.75E-05 | na | na | 3.75E-05 | 3.75E-03 |
| 1,2,3,7,8-PeCDD | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-05 | na | na | 1.13E-05 | 1.13E-03 |
| 1,2,3,4,7,8-HxCDF | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 1,2,3,6,7,8-HxCDF | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 2,3,4,6,7,8-HxCDF | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 1,2,3,7,8,9-HxCDF | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 1,2,3,4,7,8-HxCDD | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 1,2,3,6,7,8-HxCDD | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 1,2,3,7,8,9-HxCDD | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-04 | na | na | 1.13E-04 | 1.13E-02 |
| 1,2,3,4,6,7,8-HpCDF | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-03 | na | na | 1.13E-03 | 1.13E-01 |
| 1,2,3,4,7,8,9-HpCDF | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-03 | na | na | 1.13E-03 | 1.13E-01 |
| 1,2,3,4,6,7,8-HpCDD | Recreational Trespasser/Park User | mg/Kg dw | 1.13E-03 | na | na | 1.13E-03 | 1.13E-01 |
| OCDF | Recreational Trespasser/Park User | mg/Kg dw | 3.75E-02 | na | na | 3.75E-02 | 3.75E+00 |
| OCDD | Recreational Trespasser/Park User | mg/Kg dw | 3.75E-02 | na | na | 3.75E-02 | 3.75E+00 |
| Total BaPEq | Transient Trespasser | mg/Kg dw | 3.88 | na | na | 3.88 | 388 |
| Benzo(a)pyrene | Transient Trespasser | mg/Kg dw | 3.88 | na | na | 3.88 | 388 |
| Total BaPEq | Construction Worker | mg/Kg dw | 2.14 | na | na | 2.14 | 214 |
| Benzo(a)pyrene | Construction Worker | mg/Kg dw | 2.14 | na | na | 2.14 | 214 |
| Total BaPEq | Recreational Trespasser/Park User | mg/Kg dw | 0.0497 | na | na | 0.0497 | 4.97 |
| Benzo(a)anthracene | Recreational Trespasser/Park User | mg/Kg dw | 0.497 | na | na | 0.497 | 49.7 |
| Benzo(a)pyrene | Recreational Trespasser/Park User | mg/Kg dw | 0.0497 | na | na | 0.0497 | 4.97 |
| Benzo(b or k)fluoranthene | Recreational Trespasser/Park User | mg/Kg dw | 0.497 | na | na | 0.497 | 49.7 |
| Dibenzo(a,h)anthracene | Recreational Trespasser/Park User | mg/Kg dw | 0.0497 | na | na | 0.0497 | 4.97 |

**Notes:**

[1]Values shown are for receptors and chemicals shown in Table 5-8 from Willamette Cove Residual Risk Assessment (Formation 2013). Values calculated from Upland Facility-specific exposure scenarios from the Residual Risk Assessment.

[2]Upper Prediction Limit values for Portland Basin from Table 3 in Oregon DEQ. 2013. "Development of Oregon Background Metals Concentrations in Soil". March 2013.

[3]FS Hot Spot value is the lowest between the cancer or non-cancer hot spot. Non-cancer HS = RBC noncancer * 10. Cancer HS = RBC cancer * 100.

Oregon DEQ. 2003, 2012. Risk-Based Decision Making (RBDM) for the Remediation of Petroleum-Contaminated Sites. Updated RBDM values (June 2012) are available at http://www.deq.state.or.us/lq/pubs/docs/RBDMTable.pdf.

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| General Response Actions | Technology | Description | Screening Criteria: Effectiveness | Screening Criteria: Implementability | Screening Criteria: Cost | Screening Comments |
|---|---|---|---|---|---|---|
| NO ACTION | No Action | No Action | Not effective in achieving RAOs. | Easy to implement. | No capital or O&M costs incurred. | Does not meet threshold criteria. Required to be included for comparison purposes. |
| INSTITUTIONAL CONTROLS | Deed Restrictions/ Soil Management Plan | Can prevent disturbance of any required soil cap or other engineering controls, address notification of Site hazards, and ensure proper controls are implemented during future Site activities. Protocols will be established for handling and managing contaminated soils during future Site work to protect workers, public health, and the environment | Effective at regulating human direct contact, but is not effective at preventing erosion or ecological exposures, and does not address contaminant reduction. Soil management plan useful for addressing future interaction with impacted soils. | Deed restriction reasonably easy to complete. Soil management plan would need to be prepared and maintained in perpetuity. | Low costs associated with implementing soil management plan and deed restrictions. | Institutional controls are useful technologies to address risks during cleanup and to address residuals remaining after primary cleanup. Would be necessary for alternatives that maintain impacted soil on-site (such as capping). Generally only applicable to human receptors. |
| | Monitoring | Laboratory analysis of soil samples. | Effective for documenting Site conditions to evaluate migration and current Site risks. Does not address contaminant reduction. | Moderately easy to implement. Repeat sampling events may be necessary for tracking progress of active treatment technologies, which would require multiple mobilizations. | Low to moderate costs for monitoring. | Applicable to document Site conditions and effectiveness of any treatment. Must be used in conjunction with other technologies. Would include regular inspections of implemented technology (such as capping) and erosion control. |
| ENGINEERING CONTROLS | Access Restrictions | Use of fencing, signage, or other controls to limit access to impacted soils. | Effective at preventing human direct contact exposure to shallow impacted soil. Not effective at preventing erosion or ecological exposures. | Reasonably easy to implement for shallow soils. Would restrict use of property, but probably consistent with future site use. | Low costs associated with implementing controls. | Applicable especially in interim prior to park development. Addresses only human receptors, therefore must be used in conjunction with other technologies. |
| | Control of Building HVAC System | Use HVAC system to maintain positive pressure in buildings. | Not effective for inorganic or non-volatile contaminants (is used to prevent migration of volatile contaminants from soil into indoor air ). Does not address migration to other media or contaminant reduction. Generally used in conjunction with other engineering controls. | Not relevant to the site - no HVAC systems. Could be implemented for potential future construction. | Low implementation costs and low to moderate operation costs if used for future construction. | Not relevant to the Site under current or expected future conditions (no buildings onsite). Not effective for non-volatile contamination. |
| | Vapor Barriers | Installation of low-permeability barriers beneath structures to prevent vapor intrusion. Alternatively, can place sealants on floor slabs or paved surfaces. | Not effective for inorganic or non-volatile contaminants (is used to prevent migration of volatile contaminants from soil into indoor air ). Does not address migration to other media or contaminant reduction. | Easy to implement for new building construction. Products readily available for sealing improved surfaces. | Low to moderate cost for vapor barriers in new construction. | Not relevant to the Site under current or expected future conditions (no buildings onsite). Not effective for non-volatile contamination. |
| | Sub-Slab Depressurization or Sub-Floor Venting | Installation of sub-slab venting systems or suction pits to create negative pressures beneath structures to prevent vapor migration to ambient air. Vapors are collected in the suction pit or venting pipes below the building and vented to the outside of the building, either passively or with fans. | Not effective for inorganic or non-volatile contaminants. Used to prevent migration of subsurface volatile contaminants from soil into ambient air. Does not address contaminant reduction. | Easy to implement for new building construction. Materials and construction methods are readily available. Generally most suitable for buildings with slab-on-grade floors. | Low to moderate cost for installation of sub-floor venting in new construction. | Not relevant to the Site under current or expected future conditions (no buildings onsite). Not effective for non-volatile contamination. |
| CONTAINMENT | Capping | Installation of an engineered cap (e.g., soil, asphalt, impermeable liner) over impacted soils. Soil caps may include various amendments (e.g., organic matter) to reduce bioavailability of contaminants. | Effective at preventing direct contact with contaminated soils. Amendments can reduce uptake for contaminants. Does not address contaminant reduction but engineered cap can prevent erosion. Cap design can also be compatible with expected future site use. | Site is unimproved and installation of a cap would be reasonably easy. However, cap installation could eliminate existing habitat. Cap design would need to account for bank erosion potential. Cap would need to be maintained in perpetuity. Cap design could be incorporated into land use design for anticipated future use. | Moderate to high construction cost for installation of cap. Low to moderate costs for ongoing maintenance of cap to maintain effectiveness. | Potentially applicable to the site to prevent direct contact and prevent bank erosion. Thin caps with soil amendments applicable to reducing bioavailability. Specific technology used would have to be compatible with future expected use (e.g., expansive asphalt concrete cap is not applicable, but a soil cap with strategically placed paved trails may be). |
| REMOVAL AND DISPOSAL | Excavation | Excavation of some or all of the contaminated soil for subsequent treatment and/or disposal. Focused excavation may include only higher concentrations or "hot spot" soil. Site restoration could include backfill with treated soil, imported soil, or re-grading surface soil. | Effective for removing source material from site or consolidating soil under an on-site cap. Addresses direct exposure pathways and migration by reducing or controlling on-site contaminant mass. | Implementation involves conventional construction equipment and methods. Integration into land use plan would be feasible. Depending on extent of excavation, may eliminate existing habitat. | Moderate to high costs due to required soil volumes. | Applicable to the site. |
| | Off-site Disposal | Off-site disposal of excavated soil at permitted disposal facility. Soils would require waste profiling and approval by the disposal facility. | Effective for containing contaminated soils and reducing risks associated with direct exposure. | Implementation involves transportation of contaminated soils on public roads. Non-soil wastes (rock and debris) may be separable to reduce disposal volume. | Moderate to high costs depending upon soil volumes and characterization. | Applicable to the site. |
| | On-Site Disposal | Consolidate excavated soil in an on-site, capped disposal area such as a berm along the rail line to reduce noise. | Effective by consolidating on-site soil in a controlled area to prevent exposure. Because the primary concern is direct contact, a soil cap would be effective. | Implementation involves conventional construction equipment and methods. Integration into land use plan would be feasible. Depending on extent of excavation, may eliminate existing habitat. | Moderate to high costs depending upon soil volumes. | Applicable to the site. |

*Please refer to note at end of table.*

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| General Response Actions | Technology | Description | Screening Criteria | | | Screening Comments |
|---|---|---|---|---|---|---|
| | | | Effectiveness | Implementability | Cost | |
| *IN SITU* PHYSICAL/ CHEMICAL/ THERMAL TREATMENT | Soil Vapor Extraction (SVE) | SVE involves extraction of vapors from the vadose zone using system of vertical wells or horizontal vents and vacuum pumps/blowers. Treatment of the discharge may be required. | Not effective for inorganic or non-volatile contamination. | Not applicable for treatment of inorganic or non-volatile contaminants. Uses well-established technologies and implementation is straightforward, but implementation would be ineffective. | SVE system would have moderate capital and O&M costs. | Not suitable for Site conditions (shallow soils) and target contamination (inorganics and non-volatiles). |
| | Electrokinetic Separation | Application of a low-intensity direct current through the soil between electrodes that are divided into a cathode array and an anode array. This mobilizes charged species, causing ions and water to move toward the electrodes. | Effective for removing inorganic ions and polar organics from saturated soil. Most effective in low-permeability soils (particularly clays). Not effective for vadose zone soil without supplemental saturation. Not effective for all contaminants. | Requires significant power supply and would require saturation of shallow soils over large area. | Very high implementation cost. | Not suitable to Site conditions (unsaturated soil). Would not address all contamination and would result in high expense with no benefit. |
| | Fracturing | Development of cracks in low-permeability or overconsolidated soils to create passageways that increase the effectiveness of other *in situ* processes and extraction technologies. | Effective in conjunction with other technologies (e.g., vapor extraction) in deep, fine-grained or consolidated soils. Not effective with shallow soil. | Specialized equipment and personnel needed to safely implement. | Moderate implementation cost. | Not suitable for Site conditions (shallow unconsolidated soil). Not beneficial to technologies applicable to the site. |
| | Chemical Oxidation | Chemically converts hazardous contaminants to less toxic compounds. Effective in destroying organic contaminants and oxidizing inorganic contaminants to less toxic/less mobile forms. Can include oxidant chemicals such as peroxides, permanganates, or ozone. | Can be highly effective at destruction of organic contaminants or oxidation of inorganics. Can be difficult to achieve full coverage (contact between oxidant and COIs), particularly in unsaturated soils. Not applicable to site inorganic contaminants. Would be destructive to existing beneficial organics in soil. | Equipment and vendors are readily available. Delivery difficult in unsaturated soils. | High to Very High implementation cost. | Although Potentially applicable to organic contaminants, the benefit to site inorganic contaminants is limited at best. High cost and significant material handling effort likely required. Given that metals and organics are mostly co-located, not applicable to site. |
| | Soil Flushing | Water (or water containing an additive to enhance contaminant solubility) is circulated through the soil to desorb contaminants, recovered, and treated. Implementation can involve injection followed by removal (such as via vacuum truck). | May be effective for soluble inorganics but would require groundwater extraction/treatment operation and ongoing saturation of vadose zone treatment area. | Difficult to maintain control of amended water. Inefficient process for unsaturated soils. | High implementation cost. | Not retained because less effective in shallow unsaturated zone. Would require significant infrastructure for water extraction and treatment. High associated cost with no benefit. |
| | Solidification/Stabilization/ Vitrification/Immobilizatioin | Contaminants are physically bound or enclosed within a stabilized mass (solidification and vitrification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization), or additives are uses to to reduce mobility or bioavailability of contaminants (immobilization). Could be directly applied/mixed with soil or applied as part of an active capping approach. | Potentially suitable to reducing mobility of and accessibility to site contaminants. Difficult to ensure complete enclosure of soil with in-situ process. Reduction of bioavailability of organic contaminants could be effective with use of (for example) carbon addition to soil. | Difficult to obtain full stabilization in-situ in heterogeneous subsurface by injection. Vitrification would require significant power supply. Finished product would not be compatible with anticipated future site use. Incorporation of additives into cap materials relatively simple. | High to very high implementation cost, except that incorporation of additives into cap material relatively inexpensive. | Immobilization to reduce bioavailability retained as potentially useful technology to combine with capping. Other process options not retained because less suitable to Site conditions and high cost. |
| | Thermally-Enhanced Removal | High-energy injection (steam/hot air, electrical resistance, electromagnetic, fiber optic, radio frequency) is used to increase the recovery rate of semi-volatile or non-volatile compounds to facilitate extraction (enhanced volatilization or decreased viscosity). | Most suitable to semi-volatile organic contaminants or viscous compounds that are not otherwise extractable with vapor extraction or fluid extraction technologies. Not effective with inorganics. | Generally used in conjunction with SVE system or other recovery system (i.e., groundwater extraction). Has high energy requirements. Not applicable for treatment of inorganic contaminants. | High implementation cost. | Not effective for inorganic contamination. |
| *IN SITU* BIOLOGICAL TREATMENT | Bioventing | Bioventing involves inducing air or oxygen flow in the unsaturated zone to promote biodegradation of hydrocarbons and VOCs. Applications include injection of air or oxygen into subsurface, or extraction of air at rates lower than for SVE. | Not effective with inorganic contaminants. Degradation of site-specific organic COCs expected to be very slow. | Not applicable for treatment of inorganic Site contaminants. Uses well-established technologies and implementation is straightforward, but implementation would be ineffective. | Low to moderate capital and O&M costs. | Not effective for inorganic contamination. |

*Please refer to note at end of table.*

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| General Response Actions | Technology | Description | Screening Criteria: Effectiveness | Screening Criteria: Implementability | Screening Criteria: Cost | Screening Comments |
|---|---|---|---|---|---|---|
| *IN SITU* BIOLOGICAL TREATMENT—CONTINUED | Enhanced Bioremediation (Bioaugmentation, Biostimulation) | Adding nutrients, electron donor/acceptor, or other amendments to enhance bioremediation. | Most effective with organic contaminants, but can be used to change oxidative state of inorganics. Can be difficult to achieve full coverage (contact with COIs), particularly in unsaturated soils. | Would require saturation of treatment area, and would be inefficient for stabilization of target COIs. | Low to moderate costs depending on number of injection events required. | Not suitable for shallow unsaturated soil and would have marginal benefit (if any) to site contaminants. Any benefit would be slow to complete and would not be compatible with anticipated future site use in the meantime. |
| | Land Treatment | Combination of aeration (tilling) and amendments to enhance bioremediation in surface soils. | Effective for organic contaminants in shallow soil that can be degraded aerobically. Not effective for deeper contamination or inorganics. | Common agricultural equipment can be used to process shallow soil. Not applicable for treatment of inorganic contaminants. | Low to moderate implementation cost. | Not retained because incompatible with Site contamination. Similar application with potentially viable additives (i.e., oxidants) covered under chemical oxidation alternative. |
| | Monitored Natural Attenuation | Using natural processes to reduce contaminant concentrations to acceptable levels. Process is closely monitored to verify exposures are acceptable prior to concentrations reaching acceptable levels. | Most effective with organic contaminants, but natural processes can change oxidative state of inorganics. Likely unable to effect change in unsaturated soils. | Easy to implement. Monitoring of unsaturated soil would require repeated intrusive sampling events. Implementation would likely be ineffective. | Moderate costs for monitoring. | Not retained because ineffective with Site contaminants and conditions (i.e., shallow unsaturated soil). |
| | Phytoremediation | Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil or sediment. | Can be effective at removing a variety of organic and inorganic compounds from soil through plant uptake in vicinity of roots (rhizosphere). | Requires significant land area suitable for large plants. Contamination must be accessible to plant root zones. Likely not compatible with anticipated future site use because required plant management not consistent with natural park. | Low to moderate implementation cost. | Although potentially suitable for some of the Site contaminants of concern, not suitable for long-term intended site use as a park. |
| *EX SITU* PHYSICAL/ CHEMICAL/ THERMAL TREATMENT | Chemical Extraction | Excavated soil is mixed with an extractant, which dissolves the contaminants. The resultant solution is placed in a separator to remove the contaminant/extractant mixture for treatment. | Most suitable to removal of semi-volatile and inorganic contamination from excavated soil. Extracted solute/contaminants would be disposed of as a concentrated waste and treated soil could be reused as backfill. | Can be effective in removing most organic or soluble inorganic contaminants from soil. Difficult to remove all contaminant/extractant mixture from soil—would likely require finish treatment. Requires area for soil treatment or transport to off-site facility. Extractant fluid would need subsequent treatment process or disposal. | High implementation cost. | Not retained for excavated soil as significant additional cost over soil disposal with insufficient benefit (treatment costs significantly higher than disposal costs). |
| | Solidification/ Stabilization | Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). | Potentially suitable to reduce leaching of contaminants prior to disposal. | Could be used to solidify wet soil or stabilize inorganics if needed for acceptance of excavated soil at the disposal facility. Successfully used on prior removal action at the site. | Low to Moderate implementation cost. | Retained as potentially applicable to soil fraction of excavated soil if stabilization has benefit for disposal. |
| | Dehalogenation | Reagents are added to soils contaminated with halogenated organics to remove halogen molecules. | Effective at detoxifying halogenated organic compounds in excavated soil. Not applicable to inorganics or non-halogenated COCs. | Requires mixing of reagents (in on-site process or off-site plant). Likely requires further treatment or disposal of processed soil. | Moderate to high implementation cost. | Not retained because incompatible with Site contaminants. |
| | Incineration | High temperatures are used to combust (in the presence of oxygen) organic constituents in hazardous wastes. | Effective at removing organic contaminants from excavated soil. Not applicable to inorganics (though can change the oxidative state). | Requires transport to off-site facility (long-distance interstate transport—nearest facility in Nebraska, distance of 1,200 miles). Not applicable to site contaminants. | High implementation cost. | Not retained because incompatible with Site contaminants. |
| | Soil Washing | Contaminants are separated from the excavated soil with wash-water augmented with additives to help remove organics. | Most suitable to removal of semi-volatile and inorganic contamination from excavated soil. Extracted solute/contaminants would be disposed of as a concentrated waste and treated soil could be reused as backfill. | Requires area for soil treatment or transport to off-site facility. Resultant fluid would need subsequent treatment process or disposal. | Moderate to high implementation cost. | Not retained for excavated soil as significant additional cost over soil disposal with insufficient benefit (treatment costs higher than disposal costs). |
| | Solar Detoxification | Contaminants are destroyed by photochemical and thermal reactions using ultraviolet energy in sunlight or artificial UV light. Usually involves application of catalyst agent. | Can be effective at treating a variety of organic compounds. Not applicable to inorganics. | Implementation with sunlight limited by availability (not effective during nighttime and limited effectiveness in cloudy/wet seasons). Not applicable to site contaminants. | Low to moderate implementation cost. | Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation. |
| | Thermal Desorption/ Pyrolysis/ Hot Gas Decontamination | Waste soils are heated to either volatilize (desorption and hot gas) or to anaerobically decompose (pyrolysis) organic contaminants. Off-gas is collected and treated. | Effective at removing organic materials from excavated soil (particularly volatile organics). Pyrolysis generally used for semi-volatiles or pesticide wastes. Would not be effective for inorganics. | Not applicable to treatment of inorganic contaminants. | Moderate to high implementation cost. | Not retained for excavated soil as incompatible with inorganic COCs and significant additional cost over soil disposal with insufficient benefit (treatment costs higher than disposal costs). |

*Please refer to note at end of table.*

Table 3
Initial Screening and Evaluation of Technologies for Soil
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| General Response Actions | Technology | Description | Screening Criteria: Effectiveness | Screening Criteria: Implementability | Screening Criteria: Cost | Screening Comments |
|---|---|---|---|---|---|---|
| *EX SITU* PHYSICAL/ CHEMICAL/ THERMAL TREATMENT—CONTINUED | Separation | Separation techniques concentrate contaminated solids through physical, magnetic, and/or chemical means. These processes remove solid-phase contaminants from the soil matrix. | Effective for removal of solids with distinct physical characteristics (size, composition, etc.). | Commercial equipment available for separation by size (sieving) or for removing iron (magnetic removal). | Low to moderate cost. | May be potentially applicable for removal of rock fraction and debris from excavated soil prior to offsite disposal (reducing disposal volume). Not expected to directly separate contaminants. |
| *EX SITU* BIOLOGICAL TREATMENT | Biopiles | Excavated soils are mixed with soil amendments and placed in aboveground enclosures and aerated with blowers or vacuum pumps. | Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process. | Not applicable to treatment of inorganic contaminants. | Low to moderate cost. | Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation. |
| | Composting | Excavated soil is mixed with bulking agents and organic amendments to promote microbial activity. | Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process. | Not applicable to treatment of inorganic contaminants. | Low to moderate cost. | Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation. |
| | Landfarming | Excavated soil is placed in lined beds and periodically tilled to aerate the soil. | Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process. | Not applicable to treatment of inorganic contaminants. | Low to moderate cost. | Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation. |
| | Slurry Phase Biological Treatment | An aqueous slurry of soil, sediment, or sludge with water and other additives is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. When complete, the slurry is dewatered and the soil is disposed of. | Effective for removal of organic contaminants from excavated soil. Would not be effective for inorganics and organic COCs would likely react slowly to process. | Not applicable to treatment of inorganic contaminants. Would require significant infrastructure for treatment and management of soil volume and slurry water. | Moderate to high implementation cost. | Not retained because incompatible with Site contaminants. Long-term process not compatible with anticipated future site use during implementation. |

*Note:*
1. Shading indicates technology has been eliminated from consideration.

Table 4a
Cost Table – Alternative 2: Cap (1-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| | | | | | | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Engineering |
| Permitting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $243,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $214,500 | /each | $214,500 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 8 | months | $630 | /month | $5,100 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 70 | day | $400 | /day | $28,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $6,200 | /ac | $71,300 | Means (cut and chip trees, close-cut stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Site Grading | 23 | ac | $2,100 | /ac | $48,300 | Means |
| Purchase/Deliver Topsoil for Cap (6 inches) | 29,000 | ton | $22.61 | /ton | $655,700 | Means; assumes 1.6 ton/cy |
| Purchase/Deliver Import Fill for Cap (6 inches) | 31,000 | ton | $12.40 | /ton | $384,400 | Means; assumes 1.7 ton/cy |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $235,950 | /each | $236,000 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $2,596,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 80 | day | $500 | /day | $40,000 | Professional judgment |
| Engineering Oversight | 70 | day | $1,500 | /day | $105,000 | Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $325,000 | /each | $32,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $198,000 | |
| Long-Term (Net Present Value) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 | yr | $6,051 | /yr | $28,200 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Value) | | $216,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $3,253,000 | | $488,000 | Professional judgment |
| Total | | | | Total | $3,750,000 | |

Notes:

1) Means - 2014 RS Means Online Cost Estimating

Table 4b
Cost Table – Alternative 2: Cap (2-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | Unit Cost | Extension | Notes |
|---|---|---|---|---|
| Capital | | | | |
| Design, Permitting, and Procurement | | | | |
| Work Plan Preparation | 1 LS | $20,000 /each | $20,000 | For DEQ review and approval |
| Survey | 23 ac | $3,600 /ac | $82,800 | Pre-design topographic survey (Means) |
| | | | | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port |
| Drawings and Specifications | 1 LS | $85,000 /each | $85,000 | Engineering |
| Permitting | 1 LS | $20,000 /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 LS | $15,000 /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 LS | $20,000 /each | $20,000 | Professional judgment |
| | | Design and Procurement Subtotal | $243,000 | |
| Construction | | | | |
| Utility Locating | 24 hr | $70 /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 LS | $316,060 /each | $316,100 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 sy | $20.60 /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 lf | $1.06 /foot | $4,800 | Means |
| Construction Entrance | 1 LS | $1,500 /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 8 months | $630 /month | $5,100 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 120 day | $400 /day | $48,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 ac | $2,200 /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 ac | $6,200 /ac | $71,300 | Means (cut and chip trees, close-cut stumps) |
| Site Clearing (unforested) | 11.5 ac | $920 /ac | $10,600 | Means (shrub/brush mowing) |
| Site Grading | 23 ac | $2,100 /ac | $48,300 | Means |
| Purchase/Deliver Topsoil for Cap (6 inches) | 29,000 ton | $22.61 /ton | $655,700 | Means; assumes 1.6 ton/cy |
| Purchase/Deliver Import Fill for Cap (6 inches) | 93,000 ton | $12.40 /ton | $1,153,200 | Means; assumes 1.7 ton/cy |
| Place and Compact | 73,000 cy | $6.13 /cy | $447,500 | Means |
| Re-Vegetation (forested) | 11.5 ac | $41,000 /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 ac | $2,700 /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 ac | $6,560 /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 months | $6,100 /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 LS | $347,670 /each | $347,700 | Assume 10% of construction - professional judgment |
| | | Construction Subtotal | $3,825,000 | |
| Oversight and Reporting | | | | |
| Construction Management | 130 day | $500 /day | $65,000 | Professional judgment |
| Engineering Oversight | 120 day | $1,500 /day | $180,000 | Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep |
| Report | 1 LS | $20,000 /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 % | $425,000 /each | $42,500 | Assumed 10% of engineering costs |
| | | Oversight and Reporting Subtotal | $308,000 | |
| Long-Term (Net Present Value) | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 yr | $16,007 /yr | $74,400 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 yr | $25,130 /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 yr | $3,800 /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | Long-Term Subtotal (Net Present Value) | $262,000 | |
| Contingency | | | | |
| Contingency | 15 % | $4,638,000 | $696,000 | Professional judgment |
| Total | | Total | $5,340,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 5a
Cost Table – Alternative 3a: Excavation and Off-Site Disposal Using Standard Excavation (1-Foot Excavation)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $30,000 | /each | $30,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| | Design and Procurement Subtotal | | | | $233,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $369,570 | /each | $369,600 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 12 | months | $630 | /month | $7,600 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 100 | day | $276 | /day | $27,600 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 36,000 | cy | $15 | /cy | $540,000 | Means |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 72 | each | $150 | /each | $10,800 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 20 | hr | $125 | /hr | $2,500 | Soil data compilation and prepare waste profile forms |
| Transport | 65,000 | ton | $10 | /ton | $650,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 65,000 | ton | $30 | /ton | $1,950,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 200 | each | $440 | /each | $88,000 | Assume one sample per 100 linear feet perimeter; one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 58,000 | ton | $22.61 | /ton | $1,311,400 | Means; assumes 1.6 ton/cy |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $601,700 | /each | $601,700 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $6,619,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 130 | day | $500 | /day | $65,000 | Professional judgment |
| Engineering Oversight | 120 | day | $1,500 | /day | $180,000 | Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $415,000 | /each | $41,500 | Assumed 10% of engineering costs |
| | Oversight and Reporting Subtotal | | | | $307,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | Long-Term Subtotal (Net Present Worth) | | | | $187,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $7,346,000 | | $1,102,000 | Professional judgment |
| Total | | | | Total | $8,450,000 | |

Notes:

1) Means - 2014 RS Means Online Cost Estimating

Table 5b
Cost Table – Alternative 3a: Excavation and Off-Site Disposal Using Standard Excavation (3-Foot Excavation)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $30,000 | /each | $30,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| | | | Design and Procurement Subtotal | | $233,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $619,300 | /each | $619,300 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 12 | months | $630 | /month | $7,600 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 210 | day | $276 | /day | $58,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 109,000 | cy | $15 | /cy | $1,635,000 | Means |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 218 | each | $150 | /each | $32,700 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 20 | hr | $125 | /hr | $2,500 | Soil data compilation and prepare waste profile forms |
| Transport | 200,000 | ton | $10 | /ton | $2,000,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 200,000 | ton | $30 | /ton | $6,000,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 200 | each | $440 | /each | $88,000 | Assume one sample per 100 linear feet perimeter; one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 58,000 | ton | $22.61 | /ton | $1,311,400 | Means; assumes 1.6 ton/cy |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $1,281,400 | /each | $1,281,400 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $14,096,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 220 | day | $500 | /day | $110,000 | Professional judgment |
| Engineering Oversight | 210 | day | $1,500 | /day | $315,000 | Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $595,000 | /each | $59,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $505,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Worth) | | $187,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $15,021,000 | | $2,254,000 | Professional judgment |
| Total | | | | Total | $17,280,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 6a
Cost Table – Alternative 3b: Excavation and Off-Site Disposal Using Alternative Excavation (1-Foot Excavation)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $30,000 | /each | $30,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| | | | Design and Procurement Subtotal | | $233,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $453,770 | /each | $453,800 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 12 | months | $630 | /month | $7,600 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 120 | day | $276 | /day | $33,200 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load (standard) | 24,000 | cy | $15 | /cy | $360,000 | Means |
| Soil Excavation and Load (around trees) | 12,000 | cy | $85 | /cy | $1,020,000 | Means - hand excavation around minor structures, normal soil |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 48 | each | $150 | /each | $7,200 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 20 | hr | $125 | /hr | $2,500 | Soil data compilation and prepare waste profile forms |
| Transport | 65,000 | ton | $10 | /ton | $650,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 65,000 | ton | $30 | /ton | $1,950,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 200 | each | $440 | /each | $88,000 | Assume one sample per 100 linear feet perimeter; one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 58,000 | ton | $22.61 | /ton | $1,311,400 | Means; assumes 1.6 ton/cy |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $694,320 | /each | $694,400 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $7,638,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 130 | day | $500 | /day | $65,000 | Professional judgment |
| Engineering Oversight | 120 | day | $1,500 | /day | $180,000 | Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $415,000 | /each | $41,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $307,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Worth) | | $187,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $8,365,000 | | $1,255,000 | Professional judgment |
| Total | | | | Total | $9,620,000 | |

Notes:

1) Means - 2014 RS Means Online Cost Estimating

Table 6b
Cost Table – Alternative 3b: Excavation and Off-Site Disposal Using Alternative Excavation (3-Foot Excavation)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $30,000 | /each | $30,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| | | | Design and Procurement Subtotal | | $233,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $634,770 | /each | $634,800 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 12 | months | $630 | /month | $7,600 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 200 | day | $276 | /day | $55,200 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load (standard) | 84,000 | cy | $15 | /cy | $1,260,000 | Means |
| Soil Excavation and Load (around trees) | 12,000 | cy | $85 | /cy | $1,020,000 | Means - hand excavation around minor structures, normal soil |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 168 | each | $150 | /each | $25,200 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 20 | hr | $125 | /hr | $2,500 | Soil data compilation and prepare waste profile forms |
| Transport | 152,000 | ton | $10 | /ton | $1,520,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 152,000 | ton | $30 | /ton | $4,560,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 200 | each | $440 | /each | $88,000 | Assume one sample per 100 linear feet perimeter; one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 58,000 | ton | $22.61 | /ton | $1,311,400 | Means; assumes 1.6 ton/cy |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $1,154,420 | /each | $1,154,500 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $12,699,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 210 | day | $500 | /day | $105,000 | Professional judgment |
| Engineering Oversight | 200 | day | $1,500 | /day | $300,000 | Assume 15 cy trucks, 10 minutes per truck, 8 hour days, plus prep |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $575,000 | /each | $57,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $483,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Worth) | | $187,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $13,602,000 | | $2,041,000 | Professional judgment |
| Total | | | | Total | $15,650,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 7a
Cost Table – Alternative 4: Excavation and On-Site Disposal (1-Foot Excavation, 1-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $30,000 | /each | $30,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $95,000 | /each | $95,000 | Assume public bid; 14 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $25,000 | /each | $25,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $273,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $310,260 | /each | $310,300 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 6 | months | $630 | /month | $3,800 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 50 | day | $276 | /day | $13,800 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 26,000 | cy | $15 | /cy | $390,000 | Means |
| Transport/Pile | 26,000 | cy | $8.61 | /cy | $223,900 | Means |
| Confirmation Soil Sampling and Chemical Analyses | 125 | each | $440 | /each | $55,000 | Assume one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 60,000 | ton | $22.61 | /ton | $1,356,600 | Means |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $341,290 | /each | $341,300 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $3,755,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 60 | day | $500 | /day | $30,000 | Professional judgment |
| Engineering Oversight | 50 | day | $1,500 | /day | $75,000 | Assume 30 cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $315,000 | /each | $31,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $157,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 | yr | $18,012 | /yr | $83,700 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Worth) | | $271,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $4,456,000 | | $669,000 | Professional judgment |
| Total | | | | Total | $5,130,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 7b
Cost Table – Alternative 4: Excavation and On-Site Disposal (3-Foot Excavation; 2-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $30,000 | /each | $30,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $95,000 | /each | $95,000 | Assume public bid; 14 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $25,000 | /each | $25,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $273,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $479,050 | /each | $479,100 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 6 | months | $630 | /month | $3,800 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 80 | day | $276 | /day | $22,100 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 78,000 | cy | $15 | /cy | $1,170,000 | Means |
| Transport/Pile | 78,000 | cy | $8.61 | /cy | $671,600 | Means |
| Confirmation Soil Sampling and Chemical Analyses | 125 | each | $440 | /each | $55,000 | Assume one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 77,000 | ton | $22.61 | /ton | $1,741,000 | Means |
| Place and Compact | 47,000 | cy | $6.13 | /cy | $288,200 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $526,960 | /each | $527,000 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $5,797,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 90 | day | $500 | /day | $45,000 | Professional judgment |
| Engineering Oversight | 80 | day | $1,500 | /day | $120,000 | Assume 30 cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $375,000 | /each | $37,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $223,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 | yr | $27,008 | /yr | $125,500 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Worth) | | $313,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $6,606,000 | | $991,000 | Professional judgment |
| Total | | | | Total | $7,600,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 8a
Cost Table – Alternative 5: Excavation and On-Site/Off-Site Disposal (1-Foot Excavation, 1-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $30,000 | /each | $30,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $95,000 | /each | $95,000 | Assume public bid; 14 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $25,000 | /each | $25,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $273,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $349,140 | /each | $349,200 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 6 | months | $630 | /month | $3,800 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 80 | day | $276 | /day | $22,100 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 27,000 | cy | $15 | /cy | $405,000 | Means |
| Transport/Pile | 21,500 | cy | $8.61 | /cy | $185,200 | Means |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 11 | each | $150 | /each | $1,700 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 20 | hr | $125 | /hr | $2,500 | Soil data compilation and prepare waste profile forms |
| Transport | 10,000 | ton | $10 | /ton | $100,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 10,000 | ton | $30 | /ton | $300,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 125 | each | $440 | /each | $55,000 | Assume one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 60,000 | ton | $22.61 | /ton | $1,356,600 | Means |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $384,060 | /each | $384,100 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $4,225,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 90 | day | $500 | /day | $45,000 | Professional judgment |
| Engineering Oversight | 80 | day | $1,500 | /day | $120,000 | Assume 30 cy trucks on-site and 15 cy trucks off-site, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $375,000 | /each | $37,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $223,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 | yr | $17,625 | /yr | $81,900 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Worth) | | $269,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $4,990,000 | | $749,000 | Professional judgment |
| Total | | | | Total | $5,740,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 8b
Cost Table – Alternative 5: Excavation and On-Site/Off-Site Disposal (3-Foot Excavation, 2-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Work Plan Preparation | 1 | LS | $30,000 | /each | $30,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $95,000 | /each | $95,000 | Assume public bid; 14 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $25,000 | /each | $25,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $273,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $596,550 | /each | $596,600 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 6 | months | $630 | /month | $3,800 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 150 | day | $276 | /day | $41,400 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (forested) | 11.5 | ac | $9,330 | /ac | $107,300 | Means (cut and chip trees, grub stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 82,000 | cy | $15 | /cy | $1,230,000 | Means |
| Transport/Pile | 65,000 | cy | $8.61 | /cy | $559,700 | Means |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 34 | each | $150 | /each | $5,100 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 20 | hr | $125 | /hr | $2,500 | Soil data compilation and prepare waste profile forms |
| Transport | 30,000 | ton | $10 | /ton | $300,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 30,000 | ton | $30 | /ton | $900,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 125 | each | $440 | /each | $55,000 | Assume one sample per 5000 sf bottom; analyze for total metals and PAHs (10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Imported Topsoil (material and transport) | 77,000 | ton | $22.61 | /ton | $1,741,000 | Means |
| Place and Compact | 47,000 | cy | $6.13 | /cy | $288,200 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $656,210 | /each | $656,300 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $7,219,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 160 | day | $500 | /day | $80,000 | Professional judgment |
| Engineering Oversight | 150 | day | $1,500 | /day | $225,000 | Assume 30 cy trucks on-site and 15 cy trucks off-site, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $515,000 | /each | $51,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $377,000 | |
| Long-Term (Net Present Worth) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 | yr | $25,889 | /yr | $120,300 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Worth) | | $308,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $8,177,000 | | $1,227,000 | Professional judgment |
| Total | | | | Total | $9,410,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 9a
Cost Table – Alternative 6: Focused Excavation and Off-Site Disposal with Cap (1-Foot Excavation, 1-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Design Investigation | 1 | LS | $100,000 | /each | $100,000 | Better define hot spots |
| Work Plan Preparation | 1 | LS | $30,000 | /each | $30,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $25,000 | /each | $25,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $363,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $237,190 | /each | $237,200 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 9 | months | $630 | /month | $5,700 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 80 | day | $400 | /day | $32,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Excavation Site Clearing (forested) | 3.4 | ac | $9,330 | /ac | $31,800 | Means (cut and chip trees, grub stumps); 50% of excavation area |
| Cap Site Clearing (forested) | 8.1 | ac | $6,200 | /ac | $50,300 | Means (cut and chip trees, close-cut stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 5,600 | cy | $15 | /cy | $84,000 | Unit rate estimated from Means Cost Guide |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 34 | each | $150 | /each | $5,100 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 16 | hr | $125 | /hr | $2,000 | Soil data compilation and prepare waste profile forms |
| Transport | 10,000 | ton | $10 | /ton | $100,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 10,000 | ton | $30 | /ton | $300,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 80 | each | $255 | /each | $20,400 | Assume one sample per 100 lineal feet of perimeter and one sample per 5000 sf bottom; analyze for total metals (20% of samples for PAHs and 10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Site Grading | 23 | ac | $2,100 | /ac | $48,300 | Means |
| Purchase/Deliver Topsoil for Cap (6 inches) | 29,000 | ton | $22.61 | /ton | $655,700 | Means |
| Purchase/Deliver Import Fill for Cap (6 inches) | 31,000 | ton | $12.40 | /ton | $384,400 | Means |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $290,910 | /each | $291,000 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $3,201,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 90 | day | $500 | /day | $45,000 | Professional judgment |
| Engineering Oversight | 80 | day | $1,500 | /day | $120,000 | Assume 15 cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $435,000 | /each | $43,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $229,000 | |
| Long-Term (Net Present Value) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 | yr | $6,051 | /yr | $28,200 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Value) | | $216,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $4,009,000 | | $602,000 | Professional judgment |
| Total | | | | Total | $4,620,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 9b
Cost Table – Alternative 6: Focused Excavation and Off-Site Disposal with Cap (3-Foot Excavation, 2-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Design Investigation | 1 | LS | $100,000 | /each | $100,000 | Better define hot spots |
| Work Plan Preparation | 1 | LS | $30,000 | /each | $30,000 | For DEQ review and approval |
| Survey | 23 | ac | $3,600 | /ac | $82,800 | Pre-design topographic survey (Means) |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $25,000 | /each | $25,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $363,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $375,450 | /each | $375,500 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 9 | months | $630 | /month | $5,700 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 120 | day | $400 | /day | $48,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Excavation Site Clearing (forested) | 3.4 | ac | $9,330 | /ac | $31,800 | Means (cut and chip trees, grub stumps); 50% of excavation area |
| Cap Site Clearing (forested) | 8.1 | ac | $6,200 | /ac | $50,300 | Means (cut and chip trees, close-cut stumps) |
| Site Clearing (unforested) | 11.5 | ac | $920 | /ac | $10,600 | Means (shrub/brush mowing) |
| Soil Excavation and Load | 17,000 | cy | $15 | /cy | $255,000 | Unit rate estimated from Means Cost Guide |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP metals) | 34 | each | $150 | /each | $5,100 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 16 | hr | $125 | /hr | $2,000 | Soil data compilation and prepare waste profile forms |
| Transport | 30,000 | ton | $10 | /ton | $300,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 30,000 | ton | $30 | /ton | $900,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 80 | each | $255 | /each | $20,400 | Assume one sample per 100 lineal feet of perimeter and one sample per 5000 sf bottom; analyze for total metals (20% of samples for PAHs and 10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Site Grading | 23 | ac | $2,100 | /ac | $48,300 | Means |
| Purchase/Deliver Topsoil for Cap (6 inches) | 29,000 | ton | $22.61 | /ton | $655,700 | Means |
| Purchase/Deliver Import Fill for Cap (18 inches) | 93,000 | ton | $12.40 | /ton | $1,153,200 | Means |
| Place and Compact | 73,000 | cy | $6.13 | /cy | $447,500 | Means |
| Re-Vegetation (forested) | 11.5 | ac | $41,000 | /ac | $471,500 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (unforested) | 11.5 | ac | $2,700 | /ac | $31,100 | Means; hydroseeding, includes placement of mulch |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $6,100 | /month | $54,900 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $503,000 | /each | $503,000 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $5,533,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 150 | day | $500 | /day | $75,000 | Professional judgment |
| Engineering Oversight | 140 | day | $1,500 | /day | $210,000 | Assume 15 cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $555,000 | /each | $55,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $361,000 | |
| Long-Term (Net Present Value) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Cap Inspection and Maintenance | 5 | yr | $16,007 | /yr | $74,400 | Assume 1% of cap installation cost |
| Plant Inspection and Replacement/Control | 5 | yr | $25,130 | /yr | $116,800 | Assume 5% of plant installation cost |
| Long-Term Annual Inspections | 25 | yr | $3,800 | /yr | $70,100 | Inspections only years 5 through 30 (w/ summary letter) |
| | | | Long-Term Subtotal (Net Present Value) | | $262,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $6,519,000 | | $978,000 | Professional judgment |
| Total | | | | Total | $7,500,000 | |

Notes:

1) Means - 2014 RS Means Online Cost Estimating

Table 10a
Cost Table – Alternative 7: Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction (1-Foot Excavation, 0.5-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Design Investigation | 1 | LS | $100,000 | /each | $100,000 | Better define hot spots |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $30,000 | /each | $30,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $270,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $198,570 | /each | $198,600 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 6 | months | $630 | /month | $3,800 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 40 | day | $400 | /day | $16,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Excavation Site Clearing (forested) | 3.4 | ac | $9,330 | /ac | $31,800 | Means (cut and chip trees, grub stumps); 50% of excavation area |
| Site Clearing (Cap Area; non-forested Excavation) | 19.6 | ac | $920 | /ac | $18,100 | Means (shrub/brush mowing) |
| Soil Excavation and Load (standard) | 4,400 | cy | $15 | /cy | $66,000 | Means |
| Soil Excavation and Load (around trees) | 1,100 | cy | $85 | /cy | $93,500 | Means - hand excavation around minor structures, normal soil |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP arsenic) | 34 | each | $150 | /each | $5,100 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 16 | hr | $125 | /hr | $2,000 | Soil data compilation and prepare waste profile forms |
| Transport | 10,000 | ton | $10 | /ton | $100,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 10,000 | ton | $30 | /ton | $300,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 80 | each | $255 | /each | $20,400 | Assume one sample per 100 lineal feet of perimeter and one sample per 5000 sf bottom; analyze for total metals (20% of samples for PAHs and 10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Site Grading | 23 | ac | $2,100 | /ac | $48,300 | Means |
| Purchase/Deliver Topsoil | 32,000 | ton | $22.61 | /ton | $723,600 | Means |
| Bulk Activated Carbon Amendment | 130,000 | lb | $1.00 | /lb | $130,000 | EPA, OSWER 9200.2-128FS, 2013; assume 1% by dry weight to supplement topsoil organics for 25% of area |
| Apply amendment | 130,000 | lb | $0.25 | /lb | $32,500 | Professional judgment; could be direct application or blended |
| Place and Compact | 19,000 | cy | $6.13 | /cy | $116,500 | Means |
| Re-Vegetation (forested) | 3.4 | ac | $41,000 | /ac | $139,400 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (shrubs) | 11.5 | ac | $21,200 | /ac | $243,800 | Means; hydroseeding, shrubs @ 6' spacing |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $3,500 | /month | $31,500 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $248,430 | /each | $248,500 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $2,733,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 50 | day | $500 | /day | $25,000 | Professional judgment |
| Engineering Oversight | 40 | day | $1,500 | /day | $60,000 | Assume 15 cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $355,000 | /each | $35,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $141,000 | |
| Long-Term (Net Present Value) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $19,160 | /yr | $89,100 | Assume 5% of plant installation cost |
| | | | Long-Term Subtotal (Net Present Value) | | $90,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $3,234,000 | | $486,000 | Professional judgment |
| Total | | | | Total | $3,720,000 | |

Notes:

1) Means - 2014 RS Means Online Cost Estimating

Table 10b
Cost Table – Alternative 7: Focused Excavation and Off-Site Disposal with Alternate Cap and Access Restriction (1- to 3-Foot Excavation, 1-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Design Investigation | 1 | LS | $100,000 | /each | $100,000 | Better define hot spots |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Drawings and Specifications | 1 | LS | $85,000 | /each | $85,000 | Assume public bid; 12 design sheets at $5,000 per sheet plus $25,000 for Port Engineering |
| Permitting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $30,000 | /each | $30,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $270,000 | |
| Construction | | | | | | |
| Utility Locating | 24 | hr | $70 | /hr | $1,700 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $320,110 | /each | $320,200 | Assume 10% construction total (less disposal fees); includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 6 | months | $630 | /month | $3,800 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 70 | day | $400 | /day | $28,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Excavation Site Clearing (forested) | 3.4 | ac | $9,330 | /ac | $31,800 | Means (cut and chip trees, grub stumps); 50% of excavation area |
| Site Clearing (Cap Area; non-forested Excavation) | 19.6 | ac | $920 | /ac | $18,100 | Means (shrub/brush mowing) |
| Soil Excavation and Load (standard) | 13,300 | cy | $15 | /cy | $199,500 | Means |
| Soil Excavation and Load (around trees) | 1,100 | cy | $85 | /cy | $93,500 | Means - hand excavation around minor structures, normal soil |
| Impacted Soil Waste Profiling | | | | | | |
| Chemical Analyses (TCLP arsenic) | 34 | each | $150 | /each | $5,100 | 1 sample per 500 cubic yards; Unit rate from lab price list |
| Waste Profiling Data Package | 16 | hr | $125 | /hr | $2,000 | Soil data compilation and prepare waste profile forms |
| Transport | 26,000 | ton | $10 | /ton | $260,000 | Assume 3 hr round trip; 30 ton/load; $100/hr |
| Disposal | 26,000 | ton | $30 | /ton | $780,000 | Quote from Waste Management for Hillsboro Landfill |
| Confirmation Soil Sampling and Chemical Analyses | 80 | each | $255 | /each | $20,400 | Assume one sample per 100 lineal feet of perimeter and one sample per 5000 sf bottom; analyze for total metals (20% of samples for PAHs and 10% of samples for dioxins and PCBs); Unit rate from lab price list |
| Site Grading | 23 | ac | $2,100 | /ac | $48,300 | Means |
| Purchase/Deliver Topsoil | 61,000 | ton | $22.61 | /ton | $1,379,300 | Means |
| Bulk Activated Carbon Amendment | 250,000 | lb | $1.00 | /lb | $250,000 | EPA, OSWER 9200.2-128FS, 2013; assume 1% by dry weight to supplement topsoil organics for 25% of area |
| Apply amendment | 250,000 | lb | $0.25 | /lb | $62,500 | Professional judgment; could be direct application or blended |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (forested) | 3.4 | ac | $41,000 | /ac | $139,400 | Means; hydroseeding, trees @ 20' spacing, shrubs @ 6' spacing |
| Re-Vegetation (shrubs) | 11.5 | ac | $21,200 | /ac | $243,800 | Means; hydroseeding, shrubs @ 6' spacing |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for trees and shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $3,500 | /month | $31,500 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $430,130 | /each | $430,200 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $4,732,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 80 | day | $500 | /day | $40,000 | Professional judgment |
| Engineering Oversight | 70 | day | $1,500 | /day | $105,000 | Assume 15 cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $415,000 | /each | $41,500 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $207,000 | |
| Long-Term (Net Present Value) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $19,160 | /yr | $89,100 | Assume 5% of plant installation cost |
| | | | Long-Term Subtotal (Net Present Value) | | $90,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $5,299,000 | | $795,000 | Professional judgment |
| Total | | | | Total | $6,100,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 11a
Cost Table – Alternative 8: Alternate Cap and Access Restriction (0.5-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Design Investigation | 1 | LS | $100,000 | /each | $100,000 | Better define hot spots |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Drawings and Specifications | 1 | LS | $70,000 | /each | $70,000 | Assume public bid; 10 design sheets at $5,000 per sheet plus $20,000 for Port Engineering |
| Permitting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $30,000 | /each | $30,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $255,000 | |
| Construction | | | | | | |
| Utility Locating | 8 | hr | $70 | /hr | $600 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $149,350 | /each | $149,400 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 5 | months | $630 | /month | $3,200 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 30 | day | $400 | /day | $12,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (Cap Area) | 23 | ac | $920 | /ac | $21,200 | Means (shrub/brush mowing) |
| Site Grading | 23 | ac | $2,100 | /ac | $48,300 | Means |
| Purchase/Deliver Topsoil | 31,000 | ton | $22.61 | /ton | $701,000 | Means |
| Bulk Activated Carbon Amendment | 130,000 | lb | $1.00 | /lb | $130,000 | EPA, OSWER 9200.2-128FS, 2013; assume 1% by dry weight to supplement topsoil organics for 25% of area |
| Apply amendment | 130,000 | lb | $0.25 | /lb | $32,500 | Professional judgment; could be direct application or blended |
| Place and Compact | 18,000 | cy | $6.13 | /cy | $110,400 | Means |
| Re-Vegetation (shrubs) | 11.5 | ac | $21,200 | /ac | $243,800 | Means; hydroseeding, shrubs @ 6' spacing |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $3,200 | /month | $28,800 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $164,290 | /each | $164,300 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $1,808,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 40 | day | $500 | /day | $20,000 | Professional judgment |
| Engineering Oversight | 35 | day | $1,500 | /day | $52,500 | Assume 15cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $327,500 | /each | $32,800 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $126,000 | |
| Long-Term (Net Present Value) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $12,190 | /yr | $56,700 | Assume 5% of plant installation cost |
| | | | Long-Term Subtotal (Net Present Value) | | $57,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $2,246,000 | | $337,000 | Professional judgment |
| Total | | | | Total | $2,590,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 11b
Cost Table – Alternative 8: Alternate Cap and Access Restriction (1-Foot Cap)
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Alternative Component | Units | | Unit Cost | | Extension | Notes |
|---|---|---|---|---|---|---|
| Capital | | | | | | |
| Design, Permitting, and Procurement | | | | | | |
| Design Investigation | 1 | LS | $100,000 | /each | $100,000 | Better define hot spots |
| Work Plan Preparation | 1 | LS | $20,000 | /each | $20,000 | For DEQ review and approval |
| Drawings and Specifications | 1 | LS | $70,000 | /each | $70,000 | Assume public bid; 10 design sheets at $5,000 per sheet plus $20,000 for Port Engineering |
| Permitting | 1 | LS | $20,000 | /each | $20,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Procurement/Contracting | 1 | LS | $15,000 | /each | $15,000 | Professional judgment; assumes implemented/permitted w/ in-water remedy |
| Soil Management Plan/Institutional Controls | 1 | LS | $30,000 | /each | $30,000 | Professional judgment |
| | | | Design and Procurement Subtotal | | $255,000 | |
| Construction | | | | | | |
| Utility Locating | 8 | hr | $70 | /hr | $600 | Unit rate from recent subcontract |
| Mobilization | 1 | LS | $247,720 | /each | $247,800 | Assume 10% construction total; includes contractor work plans |
| Access Road Improvements | 1,420 | sy | $20.60 | /sy | $29,300 | 4-inch overlay (Means) along N Edgewater Ave |
| Erosion Control | 4,500 | lf | $1.06 | /foot | $4,800 | Means |
| Construction Entrance | 1 | LS | $1,500 | /each | $1,500 | 25 x 60 rock construction entrance (per City req's) |
| Erosion Control Maintenance | 5 | months | $630 | /month | $3,200 | 10% of Erosion Control and Construction Entrance |
| Dust Control | 55 | day | $400 | /day | $22,000 | Water truck/driver (Means); purchase water from City (0.5 gal/sy/hr) |
| Survey Control | 23 | ac | $2,200 | /ac | $50,600 | Means |
| Site Clearing (Cap Area) | 23 | ac | $920 | /ac | $21,200 | Means (shrub/brush mowing) |
| Site Grading | 23 | ac | $2,100 | /ac | $48,300 | Means |
| Purchase/Deliver Topsoil | 62,000 | ton | $22.61 | /ton | $1,401,900 | Means |
| Bulk Activated Carbon Amendment | 260,000 | lb | $1.00 | /lb | $260,000 | EPA, OSWER 9200.2-128FS, 2013; assume 1% by dry weight to supplement topsoil organics for 25% of area |
| Apply amendment | 260,000 | lb | $0.25 | /lb | $65,000 | Professional judgment; could be direct application or blended |
| Place and Compact | 36,000 | cy | $6.13 | /cy | $220,700 | Means |
| Re-Vegetation (shrubs) | 11.5 | ac | $21,200 | /ac | $243,800 | Means; hydroseeding, shrubs @ 6' spacing |
| Temporary Irrigation System | 11.5 | ac | $6,560 | /ac | $75,500 | Temporary Drip System for shrubs; cost from similar project |
| First Year of Irrigation | 9 | months | $3,200 | /month | $28,800 | Water truck/driver (Means); purchase water from City |
| Overhead, bonding, insurance | 1 | LS | $272,500 | /each | $272,500 | Assume 10% of construction - professional judgment |
| | | | Construction Subtotal | | $2,998,000 | |
| Oversight and Reporting | | | | | | |
| Construction Management | 70 | day | $500 | /day | $35,000 | Professional judgment |
| Engineering Oversight | 60 | day | $1,500 | /day | $90,000 | Assume 15cy trucks, 10 min/truck, 8 hr days |
| Report | 1 | LS | $20,000 | /each | $20,000 | Professional judgment |
| Agency Oversight (DEQ/EPA) | 10 | % | $380,000 | /each | $38,000 | Assumed 10% of engineering costs |
| | | | Oversight and Reporting Subtotal | | $183,000 | |
| Long-Term (Net Present Value) | | | | | | Assume net discount rate of 2.5% for present-worth calculations. |
| Plant Inspection and Replacement/Control | 5 | yr | $12,190 | /yr | $56,700 | Assume 5% of plant installation cost |
| | | | Long-Term Subtotal (Net Present Value) | | $57,000 | |
| Contingency | | | | | | |
| Contingency | 15 | % | $3,493,000 | | $524,000 | Professional judgment |
| Total | | | Total | | $4,020,000 | |

Notes:
1) Means - 2014 RS Means Online Cost Estimating

Table 12
Comparative Evaluation of Alternatives
Willamette Cove Upland Facility Feasibility Study
Portland, Oregon

| Release Area Alternative | Protective | Effectiveness 1 | 2 | 3a | 3b | 4 | 5 | 6 | 7 | 8 | Long-Term Reliability 1 | 2 | 3a | 3b | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 No Action | No | | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - |
| 2 Cap | Yes | + | | - | - | - | - | - | - | + | + | | - | - | - | - | - | - | 0 |
| 3a Excavation and Off-Site Disposal (Standard) | Yes | + | + | | 0 | + | + | + | + | + | + | + | | 0 | + | + | + | + | + |
| 3b Excavation and Off-Site Disposal (Alternate) | Yes | + | + | 0 | | + | + | + | + | + | + | + | 0 | | + | + | + | + | + |
| 4 Excavation and On-Site Disposal | Yes | + | + | - | - | | - | 0 | + | + | + | + | - | - | | - | 0 | 0 | + |
| 5 Excavation and On-Site/Off-Site Disposal | Yes | + | + | - | - | + | | + | + | + | + | + | - | - | + | | + | + | + |
| 6 Focused Excavation and Offsite Disposal with Cap | Yes | + | + | - | - | 0 | - | | + | + | + | + | - | - | 0 | - | | 0 | + |
| 7 Focused Excavation and Offsite Disposal with Alternate Cap and Access Restriction | Yes | + | + | - | - | - | - | - | | + | + | + | - | - | 0 | - | 0 | | + |
| 8 Alternate Cap and Access Restriction | Yes | + | - | - | - | - | - | - | - | | + | 0 | - | - | - | - | - | - | |

| Release Area Alternative | Implementability 1 | 2 | 3a | 3b | 4 | 5 | 6 | 7 | 8 | Implementation Risk 1 | 2 | 3a | 3b | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 No Action | | + | + | + | + | + | + | + | + | | + | + | + | + | + | + | + | + |
| 2 Cap | - | | + | + | + | + | + | - | - | - | | + | + | + | + | + | - | - |
| 3a Excavation and Off-Site Disposal (Standard) | - | - | | - | + | + | - | - | - | - | - | | - | - | - | - | - | - |
| 3b Excavation and Off-Site Disposal (Alternate) | - | - | + | | + | + | 0 | - | - | - | - | + | | - | - | - | - | - |
| 4 Excavation and On-Site Disposal | - | - | - | - | | + | - | - | - | - | - | + | + | | + | + | - | - |
| 5 Excavation and On-Site/Off-Site Disposal | - | - | - | - | - | | - | - | - | - | - | + | + | - | | - | - | - |
| 6 Focused Excavation and Offsite Disposal with Cap | - | - | + | 0 | + | + | | - | - | - | - | + | + | - | + | | - | - |
| 7 Focused Excavation and Offsite Disposal with Alternate Cap and Access Restriction | - | + | + | + | + | + | + | | - | - | + | + | + | + | + | + | | - |
| 8 Alternate Cap and Access Restriction | - | + | + | + | + | + | + | + | | - | + | + | + | + | + | + | + | |

| Release Area Alternative | Reasonableness of Cost 1 | 2 | 3a | 3b | 4 | 5 | 6 | 7 | 8 | Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 No Action | | + | + | + | + | + | + | + | + | 8 | na |
| 2 Cap | - | | + | + | + | + | + | + | - | -1 | 4 |
| 3a Excavation and Off-Site Disposal (Standard) | - | - | | - | - | - | - | - | - | -6 | 6 |
| 3b Excavation and Off-Site Disposal (Alternate) | - | - | + | | - | - | - | - | - | 1 | 3 |
| 4 Excavation and On-Site Disposal | - | - | + | + | | + | - | - | - | -7 | 7 |
| 5 Excavation and On-Site/Off-Site Disposal | - | - | + | + | - | | - | - | - | -8 | 8 |
| 6 Focused Excavation and Offsite Disposal with Cap | - | - | + | + | + | + | | - | - | -2 | 5 |
| 7 Focused Excavation and Offsite Disposal with Alternate Cap and Access Restriction | - | - | + | + | + | + | + | | - | 8 | 1 |
| 8 Alternate Cap and Access Restriction | - | + | + | + | + | + | + | + | | 7 | 2 |

*Notes:*

+ = The alternative is favored over the compared alternative (score=1)

0 = The alternative is equal with the compared alternative (score=0)

- = The alternative is less favorable than the compared alternative (score=-1)

na = Not protective, therefore not ranked

| Alternatve | Compared Against: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Alternative 1 | | 2 | 3a | 3b | 4 | 5 | 6 | 7 | 8 |
| Alternative 2 | 1 | | 3a | 3b | 4 | 5 | 6 | 7 | 8 |
| Alternative 3a | 1 | 2 | | 3b | 4 | 5 | 6 | 7 | 8 |
| Alternative 3b | 1 | 2 | 3a | | 4 | 5 | 6 | 7 | 8 |
| Alternative 4 | 1 | 2 | 3a | 3b | | 5 | 6 | 7 | 8 |
| Alternative 5 | 1 | 2 | 3a | 3b | 4 | | 6 | 7 | 8 |
| Alternative 6 | 1 | 2 | 3a | 3b | 4 | 5 | | 7 | 8 |
| Alternative 7 | 1 | 2 | 3a | 3b | 4 | 5 | 6 | | 8 |
| Alternative 8 | 1 | 2 | 3a | 3b | 5 | 6 | 7 | 7 | |